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Rethinking 3D Visualisation

From photorealistic visual aid to multivocal environment to study and communicate cultural heritage.

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**Rethinking 3D digital visualisation: from
photorealistic visual aid to multivocal environment
to study and communicate cultural heritage**

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Abstract

This research presents the issue of opacity in 3D visualisations of cultural heritage and explains how it prevents 3D technologies from being used to their full extent in an academic context. The impossibility to assess the provenance of the sources, cite references or identify individual contributions make the majority of available 3D models closer to mere illustrations than tools for the study and understanding of the past, regardless the amount of research that has informed the creation of the visual output.

An analysis of some of the existing strategies of documentation of 3D visualisations highlights the current lack of a standard, or even a common language, that would make such documentations comparable and cross searchable. This work suggests the use of a simple, sustainable and well-established technology as Linked Open Data, together with a tailored domain ontology, as a possible approach. The use of the synthetic and formalised vocabulary of an ontology, with its classes and properties, is used experimentally, as a proof of concept, to document the 3D visualisation of an ancient building, the Iseum in Pompeii, and to connect each part of the model to the documents that have been used as sources. The proof of concept also shows how the application of LOD technology can, potentially, change the way 3D visualisation is used in academia, not only making 3D models documented and, therefore, closer to a scientific publication, but, also, encouraging exchange and reuse of data and facilitating preservation.

The thesis discusses the rationale behind the creation of the ontology, its application to the documentation of a complex 3D model and its contribution towards a collaborative and transparent use of 3D technologies in academia. The 3D models, the ontology, and the text are equally important components of this work.

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1. Introduction

This work presents the use of Linked Open Data, and a bespoke ontology, as a means to document 3D visualisation for cultural heritage, and to change it from a static picture of the past, to a hub of a open-ended and collaboratively developed network of information.

This chapter also advocates that documentation of scholarly 3D visualisations should be standardised, to enable comparison and cross search between different projects. Among the many and varied strategies for documenting 3D visualisation that have been experimented with in the past years, this work proposes the use of Linked Open Data and of a new field ontology, named Semantic Collaborative Ontology for 3D visualisation of Cultural Heritage (SCOTCH). Adopting this technology, the documentation will necessarily be standardised, as it relies on controlled vocabularies, and synthetic, as it is based on formalised statements in the form of subject-predicate-object (RDF triples). The documentation framework for scholarly 3D visualisation here proposed is, therefore, time- and cost-effective, and produces a lightweight output that can be expressed in an established standard, such as XML.

Besides the most apparent benefits of a standard for documentation of 3D visualisations, this thesis argues that the proposed approach will also change the way 3D visualisation is perceived and used in academia, moving the focus from the final product to the process. The documentation framework here described enables the practitioners to express information about:

- The spatial relationships between the place or object represented (referent) and its parts;
- The referent and its various representations, including 3D visualisations;
- Each 3D representation and the sources it has relied upon.

Through Linked Open Data connections, a 3D visualisation potentially becomes an open-ended, collaborative, virtual forum for discussion and comparison of hypotheses, and a meaningful way to explore digital resources. This approach will contrast with the misleading impression of certainty and completeness that is usually associated with 3D visualisations, and will allow a plurality of voices in the discourse around representation of a piece of cultural heritage.

As this chapter anticipates, a proof of concept has been developed in order to test and discuss the potential of the SCOTCH documentation framework. Two 3D models of an ancient building have been entirely documented in Linked Open Data, via the proposed controlled vocabulary. The Roman city of Pompeii, and, in particular, the iconic buildings in the Iseum complex, have been chosen as case study, due to their popularity and their long history as an attraction, appealing to different types of audiences.

In the literature review, I will analyse different aspects of some of the existing documentation approaches, selected especially, but not only, among projects dealing with archaeological heritage and, in particular, with Roman architecture. Both the modelling processes, 3D visualisation and knowledge representation, will be described in the subsequent chapters, with reference to their rationale and their practical application in the case study.

In conclusion, I will argue that the SCOTCH documentation standard will contribute to integrate 3D visualisation into the workflow of academic research, and to unveil its potential as an investigative tool. The intersection between 3D visualisation and Linked Open Data will be presented as a door opened on an unprecedentedly rich and stimulating scenario, able to enhance our understanding and representation of past material culture.

1.1 Literature review: scholarly 3D visualisation and its documentation.

The term '3D visualisation' in this context defines digitally generated three dimensional representations of objects, both concrete and abstract. More specifically, 3D visualisation can be divided into '3D modelling', which involves the use of Computer Aided Design (CAD) software and the creation of 3D surfaces from scratch, and '3D imaging', which entails the digital recording of information on the shape and colour of existing objects. The separation between these two strands is by no means clear, and there are several intermediate approaches that blend multiple techniques.

The use of 3D technologies has become increasingly common in the study, preservation and communication of cultural heritage and in particular of ancient heritage. In academic debate, projects involving one or more 3D technologies are often discussed in both digitally-

focused and traditional conference venues;¹ in the non-academic sector, a growing number of museums and historical sites offer 3D content on their website or on dedicated mobile apps in order to engage the public.² The increasing rising affordability of 3D software and equipment, and the usability of their interfaces, combined with the recent boom in 3D printing (Wohlers 2014), have made digital platforms to upload, share and download 3D content popular among expert and non expert audiences.³ Augmented reality (AR) applications are also becoming a familiar way to experience and study ancient sites, from apps to be consumed on portable devices,⁴ with or without the aid of headsets, to spectacular events with projections and theatrical effects.⁵ Moreover, the tragic dramatic circumstances that have recently caused the destruction of several ancient sites in the Middle East have stimulated a number of projects featuring 3D imaging campaigns and other initiatives to reproduce what is now lost in the material world virtually, starting from existing photographic documentation.⁶

The first applications of digital visual techniques in archaeology and cultural heritage date to the 1990s. They were commonly grouped under the name of “Virtual Archaeology.”⁷ According to the definition of Forte (2000):

virtual archaeology can be defined as digital reconstructive archaeology, computational epistemology applied to the reconstruction of three-dimensional archaeological ecosystems [...] (Forte 2000:247)

¹ As can be seen looking at the on line programmes, conferences like the CAA (Computer Applications for Archaeology) offer a substantial number of papers on 3D modelling and imaging. See further 2015 full program at <http://2015.caaconference.org/program/> and 2016 abstracts at <http://2016.caaconference.org/abstracts-2/>. Likewise, the last world conference on Digital Humanities (Krakow 2016) has seen keywords like “3D” and “virtual” increasingly in popularity (abstracts at: <http://dh2016.adho.org/abstracts/>) Even a very traditional venue, such as the Classical Association conference, hosted a paper on the use of 3D visualisation (Edinburgh 2016).

² Cf., for example, the 3D content available on the Smithsonian Museum's website (<http://3d.si.edu/>), or on the Petrie Museum website (<http://www.ucl.ac.uk/3dpetriemuseum>).

³ Cf., for example, the accounts on 3D platforms such as Sketchfab owned by cultural institutions such as the British Museum (<https://sketchfab.com/britishmuseum>), the Horniman Museum (<https://sketchfab.com/HornimanMuseum>) or the Royal Museum for Central Africa (<https://sketchfab.com/africamuseum>).

⁴ Cf., for example, the app to explore the city of Matera, *Matera città narrata* developed by the Italian CNR (<http://www.itabc.cnr.it/progetti/matera-citta-narrata>), the mobile app on Roman Aquileia, *Virtual Aquileia* developed by Ikon (<https://www.ikon.it/Portfolio/AquileiaVirtuale>) and the AR exhibition on the Ara Pacis in Rome *L'ara com'era* developed by Zetema (http://www.arapacis.it/mostre_ed_eventi/eventi/l_ara_com_era).

⁵ Such as, for example, the very successful performance based on virtual reconstructions and 3D projections in the Market of Augustus in Rome in 2014 (*Il Foro di Augusto 2000 anni dopo*).

⁶ Various projects, such as the New Palmyra (<http://www.newpalmyra.org/>), aim at collecting images of destroyed or endangered cultural heritage, to produce 3D models.

⁷ The term was first used by Reilly in 1991.

These projects were mainly oriented to virtual restoration and unification of dispersed collections. They were used to enhance contextualisation of ancient artefacts and, more generally, they were meant to communicate the past in a more accessible way and to a larger audience (Favro 2006). Today, 3D visualisations are diverse and involve a wide range of approaches. Even leaving aside the applications in other disciplines,⁸ the number and the complexity of the possibilities have significantly risen in the last years, and researchers now have a new, and constantly evolving, set of tools to investigate ancient cultural heritage. For example, 3D models can be used to perform Space Syntax Analysis (Paliou et al 2011), test structural and geometrical issues in ancient buildings (Johanson 2009), reproduce light effects, shadows and reflections (Devlin 2012); visualise relationships with the archaeo-landscape (Forte 2007), calculate planetary alignments (Frischer and Fillwalk 2012) and much more.

In spite of this exciting panorama of possibilities, 3D visualisation does not seem to be fully integrated in the academic workflow, and it is still considered, in many cases, more an illustration of external research than an investigation tool in its own right (Hermon 2008). Its value as a means to generate new, relevant information is often not recognised by classicists, archaeologists and art historians, and 3D models are still mainly regarded as communicative products, explicitly targeting non expert audiences (Frischer et al. 2002). Although it can be easy to understand the caution of the academics using 3D tools in their research (Frischer et al. 2002, Denard 2012), the diffidence towards these digital outputs cannot be simply dismissed as resistance to change and technophobia.

This lack of trust has probably been caused by many different and interrelated reasons. According to Goodrick and Earl (2004), the initial enthusiasm for the possibilities offered by the new technologies diverted attention from the need for a new methodology. Moreover, the fact that the first sponsors of 3D applications for archaeology were IT companies put an explicit stress on the technological qualities more than on the knowledge production. As Goodrick and Earl remark:

The end result was an impression that virtual archaeology is:

⁸ 3D techniques, from imaging to printing, are, for example, widely used in biology and medicine. Cases of 3D printed customised artificial limbs or skeleton parts are countless.

- *very expensive*
- *technically very demanding*
- *of little interpretative value* (Goodrick & Earl 2004)

According to Favro (2006), another reason can be found in the lack of collaboration and dialogue between the community of 3D modellers and those of art historians, archaeologists and architects. The dissemination of many 3D visualisations with very little (or no) scientific supervision, reinforced the idea that the only possible application of these products was a (poorly researched) promotion of cultural heritage for the general public, if not pure mass entertainment. Looking at some of the most popular 3D visualisation, especially when disseminated in the form of video animation, it is not difficult to identify the attempt to look like a mainstream cinema or video game product⁹: dramatic music is used to solicit a sense of wonder and the hyper-realistic graphics are under the spotlight more than the historical information. In the words of Favro (2006:324):

Not infrequently, all historical urban re-creation are tainted by association with populist representations made for the entertainment industry. Immersive simulations, regardless of accuracy, have enduring sensationalistic appeal. Barnum and Bailey's circus presentation of 1890 entitled "The destruction of Rome under Nero" drew record crowds [...] being advertised as: A Titanic, Imperial, Historical Spectacle of Colossal Dramatic Realism Gladiators Combats and Olympian Displays. Indisputably, Immeasurably, Over-whelmingly the Most Majestic, Entrancing, and Surpassingly Splendid and Realistic Spectacle of Any Age". Clearly the aim was to awe not to educate the audience.

Further methodological concerns have risen against the use of 3D visualisation for cultural heritage, often from within the community of virtual archaeologists itself. As Frischer et al. (2002) report, the first virtual archaeology projects were completely "opaque"¹⁰: not only was it impossible to know on what archaeological or historical evidence the process of visualisation had been based, but it was extremely difficult even to identify the names and qualifications of

⁹ Cf., for example, the trailer for the educational app Ancient Aquileia, featuring 3D visualisations of Aquileia in Roman.

¹⁰ The term «opaque» is here used as opposed to «transparent», according to the *London Charter's* terminology. Cf. <http://www.londoncharter.org/>.

the authors. For example, as Frischer et al. (2002) remember, for one of the most famous pioneer digital exhibitions about Pompeii not a single archaeologist or ancient historian appeared to have been consulted:

The issues of accuracy, authentication, and scholarly input into the modeling process were brought urgently to the fore in the Pompeii CVR project of the now defunct Simlab of Carnegie Mellon University. [...]

Despite the project's financial support by the Archaeological Institute of America, no professional Pompeianists are known to have been consulted when the project was in its inception, nor to have had any major input on the final product. Predictably, professional archaeologists and art historians were not impressed by the results. (Frischer et al. 2002:5)

In this sense, 3D visualisations do not seem to guarantee the basic features required by academic publications, such as references to sources, citations and peer review (Denard 2012), and fail to ensure a fundamental principle of scientific method like the reproducibility of the process.

The issue becomes even more apparent when 3D outputs are compared with more traditional means of publication in classics and archaeology. Usually, archaeological reconstructions are disseminated in traditional scholarly publications as printed 2D images. In such publications, the original finds tend to be described with accuracy and great attention to detail. Consequently, the reconstructions are quite clearly presented as hypotheses informed by material clues, archaeological knowledge and previous scholarship. The narrative component gives an account of the inferential processes followed by the researchers, from the remains to the architectonic restoration. The process is recorded and structured so as to be accessible to the reader, and even more importantly, to reviewers, editors and publishers. In contrast, in archaeological 3D visualisations, citations and references to the sources or to other publications tend to be inadequate if not completely absent. In most cases, the only outcome that is accessible is the final 3D environment, which is supposed to be self-explanatory. In those cases in which documentation is available, the data and the model are seldom well-integrated or experienced together.

Exactness and accuracy are crucial points in archaeological reports and publications. In the traditional discipline, very precise measurements are given for objects that carry so much information that even differences on the scale of millimetres are relevant. This need for precision is further emphasised in architectural reconstructions, where material remains contain the clues to derive information about missing elements. Traditional publications also allow relatively easy comparison and discussion of different set of measurements (taken by different scholars) and different reconstruction hypotheses (Pakkanen 2002). Unveiling the speculative process makes reconstructions scientifically transparent and potentially able to be challenged or cited in subsequent studies. In contrast, as Favro (2006) points out, Computer Generated Images (CGI) tend to be perceived as “exact” just because they have been produced (and delivered) by a computer, and computers, in the public perception, are usually associated with the idea of “numbers” and “science”.

Opaque digital products can still relatively frequently be found in museums, as traditionally these institutions tend to present the audience with one single view of the artefact displayed (either material or virtual), and seldom share any information on the construction of that particular interpretation (Copeland 2004), or acknowledge the possible existence of others (Parry 2007). Even the Museo Archeologico Virtuale (MAV) in Herculaneum, where the focus is supposed to be entirely on the information delivered by the digital content, offers opaque 3D visualisations to its audiences. Most of the installations that are on display do not have any verbal component, and strongly suggest that the visitors are only invited to watch graphically appealing moving images.

The overall level of interaction is surprisingly low, in contrast to the amount of visual stimulus, which often seemed to be too high. In one of the main corridors, twelve different screens broadcast, in a loop, twelve 3D animations showing virtual reconstructions of different buildings.¹¹ There are no means to assess the accuracy of the visualisations, or their relationship to the historical sources. The only partial exception is the reconstruction of the Theatre of Herculaneum. A video animation is exhibited along with the virtual reconstruction of the buried theatre and shows, in accelerated pace, phases of the work of the researchers and modellers and the use of historical and iconographical sources. No doubt its aim is to make the

¹¹ Moreover, the videos represent (and implicitly associate) historical places, that are not actually related with Pompeii and Herculaneum such as the city of Baia or Villa Adriana in Rome.

public aware that visualisations are not mere work of artistic imagination but are grounded in scholarly research. Nonetheless, the animation is too fast and generic to deliver meaningful information about the sources. It basically “gives the idea” of the research process without showing it.

MAV probably succeeds in presenting the ruins as places that used to be inhabited. Its physical proximity with the site also promotes the idea of digital as an enhancement of, and not a substitute for, the material culture. However, in spite of the use of cutting-edge technologies, the delivery of the information is still traditional and passive. The visitor is saturated with stimuli and has no means to build a critical framework around them. In other words, MAV looks more like a *wunderkammer* than a place where 3D technologies are used to enhance the experience of visitors to the archaeological site.

Without any insight into the process of either building the 3D visualisation or its interpretation, the public’s only choice is to trust the authority of the cultural institution that hosts and promotes it. This still common use of multimedia and digital tools in museums and cultural heritage sites has been criticised for promoting a univocal, authoritative and unnuanced approach to cultural heritage, diminishing its richness and discouraging engagement (Cameron and Robinson 2007). When cultural institutions rely on their prestige to guarantee the quality and accuracy of the 3D visualisation, they further reinforce the misconception that the model proposed is the only possible or the only correct 3D image (Forte and Pietroni 2009). This issue, that was already evident in the critique of illustrations for museums and historical publications (James 1997), seems to have been perpetuated wholesale in the digital, three-dimensional medium.

Even if opaque and univocal digital visual products seem to be acceptable in a commercial environment, they surely cannot pass the threshold required by scholarly publication, and should not enter academic debate, regardless of the rigour of the research and the value of the hypotheses behind it. With most of the informative value hidden, 3D visualisations are as inadequate a publication form as would be a paper lacking authors’ names, methodological discourse, bibliography and footnotes.

1.2 The need for documented 3D visualisation of cultural heritage

If the research process, the interpretation and the use of the sources remain invisible, it is impossible for both the academic community and the larger public to assess, challenge or discuss a 3D outcome. The vision of the past that is rendered remains static and authoritative, i.e. based on the prestige of the author or institution that produced it rather than on evidence. As Merriman (2004) argues, this kind of approach hardly encourages or supports critical thinking about ancient cultural heritage. It appears clear, therefore, that to join meaningfully the academic debate, scholarly 3D visualisation needs to be documented. This is why, when in 2006 a group of leading scholars in 3D visualisation met in London to draft a fundamental set of methodological guidelines–The London Charter–documentation was one of the issues that received the most attention. According to the London Charter, in fact, documentation should be seen as a non-negotiable component of every 3D visualisation for cultural heritage:

*Sufficient information should be documented and disseminated to allow computer-based visualisation methods and outcomes to be understood and evaluated in relation to the contexts and purposes for which they are deployed.*¹²

Making 3D visualisations replicable and thus increasing their scientific value is probably the first and most evident aim of a thorough documentation, but not the only one. Starting from a technological perspective, documentation will improve the longevity of 3D files. In a panorama where 3D formats and standards change quite quickly, and sometimes unpredictably, a detailed description of the elements in the 3D visualisation, the rationale behind its creation, and the sources and references consulted can be a precious resource in the attempt to rescue or upgrade a file after a number of years. The availability of the equivalent of a bibliography (i.e. the sources consulted and researched) will also contribute to make 3D visualisations less based on the authority of their authors and more on their actual informative value. If, on the one hand, referencing sources such as ancient texts, archaeological evidence and previous scholarship might generate a sense of trust towards the image, on the other it helps to clarify that the visualisation is based on partial (and possibly incorrect) information, and therefore “visible” does not equal “certain”.

¹² Cf. London Charter, Principle 4: Documentation (available at <http://www.londoncharter.org/principles/documentation.html>).

Although the value of documentation is widely recognised, the number of 3D visualisations that feature it (in a variety of formats) is surprisingly low. The explanations for this counterintuitive phenomenon are probably many and intertwined. Starting, again, from a technological perspective, there were (and still are) many different issues related to simply publishing 3D data and meaningfully connecting the 3D files to other formats such as text, photographs or other 3D files. In addition, 3D visualisations range from single-author projects to quite specialised teams where a number of professionals with different skills¹³ are potentially involved at different stages. Therefore there is no established workflow, as techniques and competences are varied and each project can, from this perspective, be unique. Moreover, looking at the 3D visualisation displayed in museums or offered as complement to the visit of cultural heritage sites, the institutions sponsoring academic 3D visualisations seem to be more interested in the final product than the research process, and they might not be easily convinced to include documentation (i.e. something that the public allegedly does not want to see) in the budget.

However, alongside these practical complications, there are other more methodological variables that make documentation of 3D visualisation for cultural heritage particularly challenging. Documenting 3D representations of historical artefacts and places requires more consideration than the community seems to have given so far. Cultural heritage is complex and consequently its representations are even more complex.

1.3. The challenges of representing cultural heritage: a fluid, complex and multilayered object

Cultural heritage objects and places are always manifold entities. They are rich in historical information, often have an aesthetic value, and are relevant to the identities of groups of people. According to the UNESCO definition:¹⁴

Cultural heritage is the legacy of physical artefacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations.

¹³ A single 3D visualisation project might involve different experts to deal with each stage of the process, from archival research to mass modelling, texturing, lighting and animation.

¹⁴ See further: http://dbpedia.org/page/Cultural_heritage

This complexity is one of the qualities that makes them worthy of the effort of studying, preserving and promoting them, even (or especially) when they no longer exist in their materiality, or very little remains. If complexity is a richness, it is also the reason why cultural heritage is probably the most challenging object of representation, and therefore of documentation. These many interlinked and mutually influential layers will be partly artificially separated for the sake of discussion.

1.3.1 Cultural heritage objects' lives and biographies

In the first place, cultural heritage objects and in particular buildings (that will be the specific case study of this thesis, as discussed in further chapters) are not fixed in time. They constantly change and evolve. To use the metaphor of Gosden and Marshall (1999), they have “biographies”, like living things or, to be more correct, they have “cultural biographies.” Not only do ancient places and objects have a material component that, in its physicality, goes through different stages, but they also interact with the environment, other objects as well as living beings (Hodder 2012). They are modified to follow cultural, political and aesthetic trends; like people, they age and have to adapt in order to survive. This process is effectively described by Brand (specifically referring to historical buildings) as:

Endlessly raveling and unraveling skin of relationships overtime (Brand, 1994:71).

Talking about cultural heritage buildings, Brand (1994) points out not only how different categories of buildings, tend to change at a different speed,¹⁵ but also how, within the same building, different components are designed to change at different paces.¹⁶ Although Brand's main concern is improving urban design, his approach shows that change through time is a crucial component to understand buildings (new as well as ancient), and that this feature is much more complex and fragmented than we might expect. The London Charter advises that:

¹⁵ According to Brand, commercial buildings are the ones that go through the highest number of renovations, followed by the domestic ones. Last prone to change are, unsurprisingly, the public buildings.

¹⁶ Building on top of the model proposed by Duffy (1990), Brand suggests dividing buildings into six different components which have different degrees of adaptability and different resilience to change: Site, Structure, Skin, Services, Space Plan, and Stuff.

*It should be made clear to users what a computer-based visualisation seeks to represent, for example the existing state, an evidence-based restoration or an hypothetical reconstruction of a cultural heritage object or site [...].*¹⁷

But an awareness of constant change should also inform best practice in representation of cultural heritage. When producing a visualisation, one of the questions researchers should ask themselves is which moment (or moments) in the “lifetime” of the cultural heritage they are portraying. The choice should then be clearly stated in the visualisation itself. As Niccolucci (2013:33) highlights, in fact “3D models are a function of time: that is, they refer to a precise time span”. In contrast, traditional visual representations (both new digital ones and traditional ones) tend to present a single moment of the life of the object/place, and implicitly suggest that it is representative of the identity of the monument *tout court*.

Some of the issues related to time can more clearly be seen by looking at examples of material restoration of cultural heritage, especially in the case of historical buildings that have gone through many changes and repurposes. An overview of the history of restoration process (Trigg:2005), shows that often one single historical (and artistic) moment tends to be privileged, disregarding, when not actively destroying, all other layers. As Eggert (2013) reports, this was the case in the nineteenth-century United Kingdom, when the appreciation for mediaeval times (idealised and made popular by the Romantic movement) caused a wave of restorations aiming at bringing all the old churches back to their authentic (i.e. mediaeval) status. The operation entailed scraping off layers of subsequent decorations and additions, including fifteenth and sixteenth-century frescoes and architectonic features that were considered not valuable because they did not belong to the original corpus. The attempt to force the buildings back to a sort of primitive purity was doomed to fail, as taking off all the subsequent layers actively deprived these buildings of their identities. Even when performed with the same material that was used in the past, the results of these restoration processes usually felt artificial and, paradoxically, quite far from the idea of authenticity they wanted to promote (Trigg:2005). From this perspective, Eggert’s (2013) proposal to consider buildings, and other cultural heritage objects,¹⁸ as a production-consumption spectrum instead of focusing on a single moment

¹⁷ Cf. The London Charter, Principles: Documentation (<http://www.londoncharter.org/principles/documentation.html>).

¹⁸ It is interesting that Eggert uses the example of historical buildings to address issues that are common to all cultural heritage, even to manuscripts which are his main object of interest.

(usually the creation) seems particularly relevant. In his view, each of the stages of the artefact's chronology should be valued, as each of them is potentially an object of study to different researchers.

Some 3D visualisations of ancient cultural heritage have approached the issue of time by introducing a timeline tool. The UCLA projects Digital Roman Forum¹⁹ and Digital Karnak²⁰ display different phases of the development of a building (or architectural complex) through time, and the different interactions of the buildings with each other. In particular, in Digital Karnak it is possible to select a time period and see which buildings have been built, modified or destroyed during that time. Likewise, the digital project *Versailles 3D*²¹ offers, on the same online platform, different models of that architectural complex at different moments in time, highlighting the various roles the place had at each of the portrayed stages of its life. However, when a timeline is included in a visualisation project, it is often assumed that the only stage in the lifetime of the cultural heritage that is relevant is the one that goes from its creation to its destruction or rediscovery.²² On the contrary, the evolution and transformations of cultural heritage objects do not stop when they are found or exhibited, not even when they are enclosed in a glass cabinet in a museum (Messham-Muir 2005). In fact, not only do they experience change in their materiality and in the relationship with the landscape and other surrounding elements, but the way in which they are seen and perceived by human observers is also subject to evolution. The reception of cultural heritage places and objects goes far beyond their physicality, as is shown, for example, by the long list of artefacts that are still represented and discussed although they have disappeared (if they ever existed at all).²³

According to Gosden and Marshall (1999), the biography of an object does not involve simply the modality of its production and consumption, but also includes its ability to relate to human actors, to accumulate stories and interpretations.

¹⁹ Available at: <http://dlib.etc.ucla.edu/projects/Forum/timemap> (accessed 24 November 2016).

²⁰ Available at: <http://dlib.etc.ucla.edu/projects/Karnak/timemap> (accessed 24 November 2016).

²¹ Available at: <http://www.versailles3d.com/en/discover-the-3d-scale-models/> (accessed 24 November 2016).

²² *Versailles 3D* is, actually, a partial exception, as the Google Street View of the place is listed along with the historical models.

²³ Such a list would include, for example, artworks from the past that only survive in textual descriptions or copies like the Colossus of Rhodes or the Colossus of Nero.

Not only do objects change through their existence, but they often have the capability of accumulating histories, so that the present significance of an object derives from the persons and events to which it is connected. [170]

The number of possible, sometimes conflicting, interpretations is a crucial part of the identity of cultural heritage. Monuments that were considered fashionable at the time they were built can now be deemed aesthetically questionable, or vice versa, as the well-known case of the Eiffel Tower in Paris shows.²⁴ Other monuments, that were built to celebrate events and ideology of a particular group, are sometimes considered offensive or insensitive by other groups, as exemplified by the debate around Confederate memorials in the United States or Afrikaner ones in South Africa.²⁵ Restorative processes that were supposed to improve ancient artefact are now seen as crimes against the historical value of the original object.²⁶ The list of examples could be very long.

All representations are human productions, and therefore are culturally biased by their very nature. In this sense, representations tell us more about the time when they are produced than the historical time they are supposed to represent. The truth of this statement can be more easily recognised when analysing older interpretations of ancient heritage. Looking at Victorian or Edwardian representations of the past, for example, it is very easy to feel the influence of academic and cultural trends of the time, as well as the political agenda of a country or group of people, in the choice of the monuments to highlight and promote and the interpretations to disseminate (Shanks:2009). For example, as Phillips (2005:84) points out, visual representations of prehistoric Britain published at the beginning of the twentieth century quite clearly transferred to ancient times the same family structures, roles and values of the average Edwardian family, without relying on any actual material evidence:²⁷

²⁴ The monument, strongly criticised when built, turned into a national icon a century later. Cf. Thompson 2000.

²⁵ Cf., for example, Schedler 2000 for the United States, and Delmont 1993 and Mitchell 2013 for South Africa.

²⁶ Cf., for example, the controversy around the major restoration project of Michelangelo's Sistine Chapel in Rome. See also the petition signed by famous artists to stop the process: <http://www.nytimes.com/1987/03/06/arts/halt-urged-in-work-on-sistine-and-last-supper.html>

²⁷ The analysis here cited refers, in particular, to the drawing by Amédée Forestier titled "In a dwelling-place set on an artificial island in north central Somersetshire: the inside of a hut of the British Lake Village in Glastonbury" published in 1911 in the *Illustrated London News*. As reported in Phillips 2005 .

The male is the active figure, the women are passive or engaged in domestic activities. [...] Early twentieth-century gender roles are projected back onto the Iron Age to make the people in the image appear “more like us” [...] These shadowed figures could so easily be the scullery maids, the lowest of the domestic servants who carried out the tasks the lady of the house [...] would not dream of doing themselves. The man of the roundhouse can be observed entering through the door: the Edwardian gentleman returning home. [...] A truly Edwardian Iron Age has been created that provides an impression of the past that is safe and familiar.

The diversity of interpretations can be observed on (at least) two axes. On the first, vertical, one it is possible to note how the interpretation of an ancient object has evolved in the eyes of a single culture. A quite clear example can be found in the comparison of the visual records of the same limestone funerary relief held by the Ashmolean Museum (Ill. 61). The looks, the clothes and even the hairstyle of the fairly damaged human figure portraying Vivius Marcianus on its funerary relief changes quite dramatically in the different representations through time, from the seventeenth to the twentieth century.²⁸

On a second, horizontal, axis it is possible to compare how the same ancient object was or is perceived and interpreted differently by subjects belonging to different groups. Hodder and Huston (2003) support the statement that “different people in the contemporary public view the past in very different ways,” citing the work of Leone et al. (1995) on the archaeology of Annapolis, when the archaeologists realised that the voices of both enslaved and free African Americans were indispensable to the understanding and the representation of the city’s past.

The aim of documentation should be not only to create awareness about the bias of the researcher(s) through the declaration of their sources and rationale, but also to give an account of the other possible interpretations, going from uni- to multi-vocal representations of the past, putting the historical artefact at the centre of a web of different views.

1.3.2. Representing alternative hypotheses and interpretations in 3D visualisations of cultural heritage

²⁸ Such artefacts and their relationships are discussed in a post on the Ashmolean Museum Blog, *A Roman Centurion in London*. Available at <http://www.ashmolean.org/ashwpress/latininscriptions/2014/03/10/a-roman-centurion-in-london/>

Visually representing cultural heritage always involves an hypothetical component. The process of visualising (and modelling) requires countless choices among different options that are potentially equally valid (Baker 2013). The task is even more difficult when dealing with ancient heritage, where the information is transitory and fragmentary. The issue has already been highlighted in the history of archaeological interpretations: when looking at material remains (or other sources) there are various hypotheses that are pursuable, but archaeologists are usually encouraged to develop, and publish, only one (Shanks 2009).

The theoretical and practical drawbacks of pursuing one single hypothesis can be seen in many examples of material restoration, among them the Palace of Knossos in Crete. The view of a single researcher (or research group) that is, as is every view, biased and culturally determined, informs the cultural heritage itself and transforms its identity, making it impossible to separate the object from the interpretations, the two layers irremediably blended. For example, the idea of Crete that informed the restoration of the Palace of Knossos, led by British archaeologist Evans, is now part of the public experience of the archaeological site, and perceived by the audience as the image of “authentic” Minoan art and architecture (MacGillivray 2001). In his travelogue *Labels*, Waugh (1930) assess very critically the restoration of the entire palace and, in particular, that of the frescoes:

since only a few square inches of the vast area exposed to our consideration are earlier than the last twenty years, and it is impossible to disregard the suspicion that their painters have tempered their zeal for accurate reconstructions with a somewhat inappropriate predilection for covers of Vogue.

No other hypotheses can be displayed on top of the one that has thus become definitive. Documenting the existence of alternatives (in the sources as well as in the current work of the researchers) will contribute to making 3D visualisations look more like hypotheses than truths, making it easier to remember that there can be multiple (accurate) visualisations of the same ancient heritage, and that much can be learned by their comparison.

When representing things and places from the past, especially antiquity, the line between what is historical and what is fictional can be hard to establish. Moreover, 3D visualisations

sometimes represent things that never existed²⁹ such as unfinished or never-realised projects or things only described in literary sources. The difference between something that never existed and something that does not exist anymore is hard to identify neatly, when it comes to the methodology of its visual representation. In order to better present and discuss the levels of representation in 3D visualisations of cultural heritage, I will borrow the concept of “ekphrasis”. Traditionally, in classical studies, ekphrasis refers to the literary description of a work of figurative art, especially a non-existing one, the most widely known example being the description of the shield of Achilles in the Iliad. As Becker (1995) reminds us, it is often considered a rhetorical device to exemplify the power of narration or poetry itself, or to symbolise a certain predominance of verses over any figurative art. However, in a wider sense, ekphrasis defines all the descriptions or representations of a work of art in another medium of art.

Although it is perhaps unsuitable for a scholarly 3D visualisation to be considered (only) an artistic expression, it is certainly the representation of a work of art (for example a sculpture or an architectural complex) through another medium (digital 3D model) that uses a different code and language. Giving the concept of ekphrasis a slightly wider breadth and applying it to all forms of art that are represented in another medium (possibly disregarding its belonging to the “art” realm), 3D digital visualisations can be considered as such.

Introducing the concept of ekphrasis when looking at representations of historical artefacts highlights some methodological issues. A photograph of an ancient building, for example, should fall into the ekphrasis category as photography is a different medium (and indeed is universally recognised as a form of art) from that of the original object (architecture). The perspective of ekphrasis may help remind us of the subjectivity of all visual representations, even those that use more objective-looking technologies like digital imaging. It is surprising how photography, and more recently digital imaging techniques, can be perceived at the same time as an artistic medium, with famous personalities tied to a recognisable style delivering very personal messages, and as an objective means to “copy” reality. Cultural heritage conservation

²⁹ Cf. for example, Webb 2012.

initiatives such as the popular CyArk, aiming at creating digital visual records of historical sites³⁰ through digital technologies, advertise their work as a “teleporting machine”.³¹ Even one of the most popular semioticians like Barthes (1993) writes that photographs are not representations but, basically, mirrors of reality. Barthes’ (1993:272) statement assigns an intrinsic “witness value” to photographs, as if they were “messages without a code”.

An indirect answer to Barthes can be found in Ankersmit (2001) when he points out how a code that is “invisible” (or mostly invisible), as is the one used in photography, is not necessarily “absent”. Photographic images are constructed in a way that is far from immediate or neutral. Paradoxically, photographs can be built to “give the idea” of freshness and authenticity. Leaving aside the objection that photography can be (and has been) used to lie, when various pre- or post-edits are applied, even non-edited photographs cannot be considered entirely objective. One major point is made by Bohrer (2011), that photography is not about representing everything that “is there”, but is about “selecting and isolating”. In Bohrer’s (2011) words, the object of photography is not only what is included in one particular frame but also, and sometimes mostly, what is left out.

Going back to its original definition, if ekphrasis is about describing something that does not exist as if it was real, the concept is quite suitable to be applied to 3D visualisation, which is often a representation of something that the modeller has never seen, possibly because the original is damaged or completely destroyed. 3D visualisation becomes then, quite often, the process of describing via a medium (a CAD file) an artwork (or object or building) that mostly exists only in the (informed) imagination of the researchers. The same reasoning, obviously, applies, to pre-digital hypothetical restorations of ancient objects and buildings. But it is also true that 3D visualisation uses as sources of information both photographs and previous illustrations so, actually, things that are already representations or, indeed, ekphrasis themselves. A quite striking example of this chain of representation processes is given by the project *Crystal Pompeii* described by Earle and Hales (2009). The 3D model they developed represented the replica of a Pompeian house, the House of the Tragic Poet, that was on display

³⁰ According to the CyArk website, their mission is: “to ensure heritage sites are available to future generations, while making them uniquely accessible today. CyArk operates internationally as a 501(c)3 non-profit organization with the mission of using new technologies to create a free, 3D online library of the world’s cultural heritage sites before they are lost to natural disasters, destroyed by human aggression or ravaged by the passage of time.” Cf. <http://www.cyark.org/about/>

³¹ Cf. the article “CyArk Makes Dreams of Teleportation Come True with VR at SF’s Exploratorium” (2016)

in Sydenham in 1854. However, this replica was actually inspired by another replica, that had previously successfully been part of the Crystal Palace exhibition in 1851. Both models of the Pompeian house had also been made bigger, to accommodate visitors, and more regular, to conform to Victorian ideal of beauty, than the original. The latter is also one of the most heavily restored houses in Pompeii, so that it is hard to say how much even the actual remains in Pompeii can be considered “authentic”. These Chinese boxes of real and fictional, representation and interpretation, translation and remediation are, again, structurally part of cultural heritage and its relationship with the public. It becomes more and more clear that 3D visualisation of ancient objects cannot possibly represent the artefact itself, but only layers and layers of interpretation about it.

1.4 A proposal for a documentation framework for 3D visualisation of cultural heritage

In spite of general agreement on the crucial importance of documentation, there are currently no clear indications, much less accepted standards of, how to do so. The London Charter, along with other guidelines for the representation of cultural heritage,³² insist on the necessity of documentation but remain hopelessly vague in suggesting how to actually document any type of 3D visualisation, from CAD models to 3D scanings.

There have been and are, of course, examples of documented 3D visualisations of cultural heritage and more specifically of ancient heritage. A relatively easy and straightforward approach was to embed (a partial) documentation into the visual output itself. This approach, already successfully applied in some eighteenth century illustrations of antiquities,³³ can be found in more recent times applied to three-dimensional CGIs. For example, in Blazeby's (2013) hypothetical restoration of the frescoes in the Roman Villa of Oplontis, an easy-to-understand colour code would identify the reliability of the information displayed, in a sort of “street light” approach: The colour green would mark the parts of the frescoes that are based on survived fragments, the colour yellow would identify the parts that were reasonably derived from the green-coded ones, and the colour red those that were entirely guessed by the author, according

³² Cf., for example, the principles of the Sevilla Charter (<http://smartheritage.com/seville-principles/seville-principles>)

³³ Cf., for example, the simple yet effective visual code used by Francesco Piranesi to differentiate between copied elements (realistic style) and hypothetical one (synthetic style) in his representation of the Temple of Isis in Pompeii (Ill. 8)

to his knowledge and expertise (Ill. 62). Borra uses instead a lower degree of opacity to display more hypothetical elements in his visualisation of the Villa of Trajan in the Aniene Valley, superimposed on the digital imaging of the actual ruins, displayed with a full degree of opacity (Ill. 63). The voice-over accompanying the visualisation (that can only be consumed in video format) also explains that the use of white for architectural elements is not realistic, but expresses uncertainty about the original colour and decoration. Another strategy can be found in the *Poitier's Evolution* project by Art Graphique & Patrimoine. The 3D visualisation (part of an historical AR mobile app³⁴) focuses not only on the historical monuments in Poitiers (from Roman to Mediaeval times), but also on the building technologies of the time. Exploiting the specific narrative of monument building, the less certain elements appear half-hidden in clouds of dust and debris. These approaches all contribute to showing how the elements in a 3D visualisation can (and often do) have different kinds of sources, not all with the same level of historical accuracy. However, in these visual strategies, the elements in the 3D visualisation are only divided into very broad categories (sometimes just “sure” and “unsure”), without giving any account of the various intermediate positions, and without providing sufficient references to the actual sources that on the whole remain opaquely assessed by the authors, according to unknown criteria.

The most common way to document 3D visualisations is, by far, publishing a separate but related text that describes and discusses the research process, issues encountered and methodology followed. Examples are various for both 3D modelling and 3D imaging,³⁵ and often make heavy use of screenshots of the 3D outputs, as the papers are meant to be experienced separately from the visualisation in its 3D format. These publications are certainly useful and, potentially, offer room for more detailed documentation. However, it is hard to imagine how long a verbose account of all the decisions taken during the modelling or imaging process would need to be and it is even harder to imagine someone actually recording, in a journal-like style, all their actions in a research context. By necessity, these kind of papers and articles only give summary information and dramatically simplify the whole research process.

³⁴ See further https://www.poitiers.fr/c__67_944__3d_poitiers_evolution.html

³⁵ The list could be very long. Just to cite a few examples of papers discussing 3D visualisation projects, see also: Guidi, G. et al. (2004), Behr, J. et al (2001), Koutsoudis, A. et al (2007).

Some projects use digital resources, such as blog platforms,³⁶ more directly to relate the documentation to the 3D files. This solution combines some of the benefits of paper publications, without the traditional constraints—in length of text and number of images—bound to the printed medium, and digital resources allow the embedding of other formats such as videos or the 3D file itself (through a viewer or a download option). Besides the generic issues related to online self-published resources in academia, from sustainability to prestige, this choice only partially improves the value of traditional publications, and remains very verbose and idiosyncratic, as each researcher decides what to document in their work, and how. If it is true that a blog gives the opportunity to write a sort of step-by-step (although simplified) report of the process, the availability of a larger quantity of text still does not make the information better organised or more retrievable, and it is unlikely that a user would read through the entire blog when looking for a specific piece of information (such as, for example, the particular documents used as reference for a single element of the visualisation).

An approach that seems among the most effective is to present the documentation on the same digital platform (website or app) that hosts the 3D visualisation, embedding it in a more complex tool that allows exploration, and that offers contextual information about the digital and material object, and the related sources.³⁷ Information can usually be accessed clicking list of items. In some cases, a synthetic bibliography is given for each object. Although this method seems so far the most systematic and promising, it doesn't comply to any standard and remains entirely univocal, as only one interpretation is given. In other digital projects, 3D visualisations have been directly connected to the (digital copies of) archive documents that have informed the research around the visualised artefact.³⁸ In these specific cases, the interaction between visualisation and documents is very close and they complement each other. In fact, the pictures and text in the archive contribute to a basic documentation of the 3D visual output, and the 3D virtual environment offers an engaging and interactive way to access the information in the archive, and to show possible connections among the items; connections that would have been barely visible if browsed in the traditional fashion. Although very interesting for its potential, this

³⁶ Cf., for example, the documentation of the 3D visualisation of the old Abbey Theatre at <http://blog.oldabbeytheatre.net/>

³⁷ Excellent examples of this approach are the already-mentioned projects developed by UCLA: Digital Roman Forum and Digital Karnak

³⁸ Cf., for example, the work of the Digital Pompeii project at http://pompeii.uark.edu/DigitalPompeii_Content/index.html

approach does not seem to offer sufficient explanation beyond the straightforward link that connects document and visualisation, and does not seem able to account for the many possible ambiguities or controversies that are likely to arise from a work on historical documents. Also, if the 3D visualisation is meant to be connected to a specific archive or pool of resources, it usually excludes other, external resources that will also have influenced the research process.

A radical approach was suggested by Jacobson already in the early years of 3D visualisation of ancient heritage in his *PublicVR*³⁹ project. His work is pioneering in many respects, first of all in promoting the idea that 3D visualisation should be collaborative. For this reason, when developing *Virtual Pompeii*, he made available the 3D files on a dedicated web platform, inviting students and colleagues to do the same, encouraging them to download, improve, modify, comment and re-upload the visualisations (obviously, duly citing the original authors).⁴⁰ Unfortunately, this view of 3D visualisation of classical heritage did not take off, possibly due to the fear of plagiarism among modellers, or to a lack of engagement in the community. However, when analysed today, the main issue with Jacobson's work (for the *Virtual Pompeii* as well as for the others that were part of his *PublicVR* portal) is that, although he encouraged others to discuss their work, he did not provide enough information about his own visualisations (in fact, hardly any at all). Although adherence to historical knowledge is not necessarily the only possible option for a scholarly visualisation,⁴¹ the lack of documentation makes the files not really suitable for reuse or for being built upon by another researcher.⁴²

Another early approach to produce and disseminate documentation for 3D visualisation were mixed media publications: a more traditional book and the 3D file (or virtual environment) on CD Rom were distributed together, (ideally) as a single entity.⁴³ They were meant to be consumed together or, at least, one next to the other. This approach had very predictable technological issues, such as the longevity of the 3D format and the disappearance of CD drives from most current machines. A different kind of mixed media publication is now being

³⁹ See further: <http://publicvr.org/html/about.html>

⁴⁰ See further: http://pompeii.uark.edu/DigitalPompeii_Content/index.html

⁴¹ Depending on the research questions and the aims of the project.

⁴² The absence of documentation also makes the very debatable choices in the 3D visualisation of the Iseum in Pompeii not defensible. As I discussed in Vitale 2012 "[...] the first unification of the Temple of Isis appears rough, in both the 3D structure and the texturing. In the ekklesiasterion area, for example, the same few frescoes are duplicated, flipped and repeated in an unfaithful wall decorative pattern. The project shows little regard to the actual appearance of the artefacts, their dimensions and positions."

⁴³ Cf., for example, La Villa di Livia a Prima Porta (Forte 2007) or La Torre di Vendicari (Borra 2009).

experimented with by UCLA and the *Journal of the Society of Architectural Historians* (JSAH). In the article about funeral processions in Rome,⁴⁴ the 3D virtual environment is used to support and develop the theoretical argument (showing an exemplar case of the use of 3D not just to illustrate previous resources but as a tool of investigation). Therefore, the paper only reaches its full potential when the reader browses the models contextually. The models are accessed via the publisher's service.⁴⁵

This list of examples and categories of documentation strategies is by no means exhaustive, and academia is full of different approaches. All of them are interesting in different respects and show some difficulties of the documentation process when applied to ancient heritage. The main point of this brief excursus on some of the documentation options available was precisely to highlight their many differences from each other. The documentation of the projects discussed, although perhaps perfectly functional in themselves, cannot be meaningfully compared as they use different vocabularies and structures. As Addison (2007) points out, not even two projects belonging roughly to the same group are guaranteed to be homogeneous enough to allow, for example, a common search.

It seems that scholarly 3D visualisation not only needs a documentation workflow, but ideally, it also needs one with some specific characteristics: it has to consider the evolution of a piece of cultural heritage (both in its materiality and in its interpretations), link to variant hypotheses and express the complexity of the process of representation. Moreover, to be retained in a budget, it has to be relatively cheap to produce and maintain. In order actually to be carried out by already overworked researchers, it also has to be easy to learn and to apply. In short, it has to be cost- and time-effective. It should be synthetic and based on a shared vocabulary, so to act as a constraint and, implicitly, as a standard, making all the documentations that follow the same practice comparable. It should be able to document not only the final product but also the different steps of the research process,⁴⁶ and the relationship between the 3D file and the sources (or their absence). It should account for the different levels of authorship that are often involved in a 3D project and should connect the different elements

⁴⁴ Favro, D. and Johanson, C. (2010)

⁴⁵ A subscription to the journal is required to access the publication.

⁴⁶ Or, in other words, what The London Charter calls "paradata".

in the visualisation internally with each other and externally with other, related, traditional and digital visualisations.

Producing thoroughly and consistently documented 3D outputs will be a dramatic improvement in the application of 3D visualisation as a tool of research. However, I wish to argue that documentation can change the way 3D visualisation for cultural heritage is developed and perceived in an even more radical way. If documentation were not closed and self-contained but open, collaborative and dynamically updated and annotated, it would not only make 3D visualisations closer to academic publications, but also better represent the complexity of views and voices that is part of the nature of cultural heritage. In this perspective, 3D visualisation will evolve from being (seen as) mostly a simple snapshot of the past, to a dynamic node in a network of information; a 'digital humanities laboratory' (Johanson 2009:407) to test and compare hypotheses, where it is possible to dialogue with previous and contemporary research on the same topic and to offer a basis for future study. Such a view of documentation will contribute to making the use of 3D visualisation envisioned by Forte and Pietroni (2009) and Johanson not an idealistic goal, but the new standard.

1.4.1. Linked Open Data (LOD) and ontologies to document 3D visualisation

Since the development, around 2012, of 3D APIs such as WebGL⁴⁷ that allow 3D images to be rendered in web browsers without the installation of plugins, XML- and HTML-based approaches for documenting 3D visualisation seemed like a natural step forward. The opportunity to easily annotate 3D files was eventually in everyone's reach.

Another relevant premise to the encounter between 3D files and XML language can be found in the work of the Text Encoding Initiative consortium.⁴⁸ The TEI has collaboratively developed a set of rich semantic tagging that represent in XML various aspects of texts in digital form, from the material manuscript, to the apparatus criticus; from the verbal component to the scholarly choices that informed the transcription. The work of the TEI community in creating semantic documentation also for non-verbal texts such as musical notation,⁴⁹ can be seen as another indication that the routes of XML and 3D visualisation are closely related. In particular,

⁴⁷ WebGL stands for Web Graphics Library, and is a JavaScript API for rendering interactive 3D and 2D computer graphics within any compatible web browser without the use of plug-ins. See further: <https://www.khronos.org/webgl/>

⁴⁸ See further: <http://www.tei-c.org/index.xml>

⁴⁹ See further, guidelines of the Music Encoding Initiative (MEI) at <http://music-encoding.org/>

the TEI annotation of digital facsimiles based on x,y coordinates⁵⁰ seemed to point in the direction of annotation of virtual spaces. Using an additional value, i.e. the z coordinate, it would be possible to identify specific portions of a three-dimensional virtual environment and annotate it. This implementation of the TEI has to my knowledge never been developed. Moreover, this approach would have been only partially fit for my purpose. As other examples of documentation discussed in this chapter, it would allow the rich annotation of a specific 3D model, but would make the comparison between different models at least problematic, as the coordinates used as identifiers would be tied to a single 3D environment. Other attempts to combine XML and virtual heritage focussed more on the description of the object itself than its 3D representations, landing quite close to taxonomies. If the choice of XML-based documentation seemed promising in terms of sustainability and standardisation, and even opened the door to semantic connections with other digital sources, it still did not ensure that openness and multivocality for which I was aiming.

This research will show the potential offered by the Linked Open Data (LOD) technology in achieving a synthetic, but also rich, open and collaborative documentation of 3D visualisation for cultural heritage. The use of LOD, specifically in the form of RDF triples, combined with a dedicated ontology, will be presented as a means to produce dynamically and multi-vocally documented 3D visualisations. According to EuropeanaLabs documentation, Linked Open Data is:

*a way of publishing structured data that allows metadata to be connected and enriched, so that different representations of the same content can be found, and links made between related resources.*⁵¹

The roots of LOD can be found in the idea of a semantic web (Bauer & Kaltenböck 2011), i.e. in the cost-efficient publication of connected information in distributed environments. As Bauer and Kaltenböck remark, in a semantic web framework 'standards play the most crucial role' (Bauer & Kaltenböck 2011:26). The standard for the semantic web, developed by the World

⁵⁰ See further: <http://www.tei-c.org/release/doc/tei-p5-doc/en/html/PH.html>

⁵¹ Cf. <http://labs.europeana.eu/api/linked-open-data-introduction>

Wide Web Consortium⁵² (W3C), was a metadata model called Resource Description Framework (RDF). As Miller (2001) explains,

The Resource Description Framework (RDF) is an infrastructure that enables the encoding, exchange and reuse of structured metadata. RDF is an application of XML that imposes needed structural constraints to provide unambiguous methods of expressing semantics. RDF additionally provides a means for publishing both human-readable and machine-processable vocabularies designed to encourage the reuse and extension of metadata semantics among disparate information communities.

The RDF conceptual model is based on the act of making statements about resources that have been identified by a unique reference: the unique resource identifier (URI). Such statements appear, roughly, in the form of the simplest, three-word English sentence: subject, predicate, object and are, therefore, commonly referred to as “triples”.

LOD has already proven its usefulness when applied to the study of the ancient world, as very successful projects such as the Pleiades Gazetteer,⁵³ Pelagios Commons,⁵⁴ EAGLE,⁵⁵ or the Arachne archaeological database⁵⁶ show. Moreover, LOD is relatively easy to learn, and data can unproblematically be generated from traditional spreadsheets, as discussed in the W3C guidelines.⁵⁷ From a technological point of view, LOD relies on standard formats, such as XML/RDF, that, at the moment, appear to represent a reasonable investment in terms of sustainability. The digital output is also extremely lightweight and does not require a burdensome amount of space for storage. RDF triples are based on a controlled vocabulary, i.e.

⁵² See further: <https://www.w3.org/>

⁵³ Pleiades Gazetteer is “a community-built gazetteer and graph of ancient places. It publishes authoritative information about ancient places and spaces, providing unique services for finding, displaying, and reusing that information under open license.” See further: <https://pleiades.stoa.org/>

⁵⁴ Pelagios Commons “provides online resources and a community forum for using open data methods to link and explore historical places”. See further: <http://commons.pelagios.org/>

⁵⁵ Eagle, now part of Europeana, provides “a single user-friendly portal to the inscriptions of the Ancient World, a massive resource for both the curious and for the scholarly.” See further: <http://www.eagle-network.eu/about/who-we-are/>

⁵⁶ Arachne “is intended to provide archaeologists and classicists with a free internet research tool for quickly searching hundreds of thousands of records on objects and their attributes.” See further: [https://en.wikipedia.org/wiki/Arachne_\(archaeological_database\)](https://en.wikipedia.org/wiki/Arachne_(archaeological_database))

⁵⁷ See further: <https://www.w3.org/TR/ld-bp/>

only specific statements are allowed, and all are expressed with exactly the same structures and words. As the W3C stresses, all the properties and relationships must be defined online,⁵⁸ so that it is easier for different researchers to check if their use of a certain term is adequate or not, in the context of a specific ontology. The success of some LOD-based projects, such as those mentioned above, highlights two aspects that are crucial in the discussion about documentation of scholarly 3D visualisation. One is that connections between different pieces of information are an added value that is recognised by the academic community. The second is that academia, or at least part of it, and many other cultural institutions⁵⁹ are ready and willing to use LOD, and to engage directly with producing more linked data and making them available to the public. Moreover, the various (past, present and future) LOD-based projects continuously feed a pool of information and resources that is the very base of the kind of documentation here envisioned.

Another very relevant precedent to this research was the project developed by the UK Archaeological Data Service (ADS) in order to “cross search[...] over excavation datasets from different archaeological database schemas.” The project, called Semantic Technologies for Archaeological Resources (STAR), was based on Linked Data and semantic web, and used the CIDOC-CRM ontology⁶⁰ as a common language for exchange.⁶¹ As the manifestos of STAR and its sister project Semantic Technologies Enhancing Links and Linked data for Archaeological Resources (STELLAR)⁶² highlight, the use of Linked Data introduces a stress on interoperability, collaborativeness and data reuse. While being an important reference in the use of Linked Data to archaeological information, STAR and STELLAR could not configure as a choice to document 3D visualisation of cultural heritage for a number of reasons. In the first place, the chronological scope was different. More specifically, the ADS projects focus on archaeology, while my research looked at representations of cultural heritage from various periods of time. Second, STAR and STELLAR mainly focuses on excavation records. Although such documents can be considered a representation of ancient heritage, this work prefers to

⁵⁸ Cf.: <https://www.w3.org/TR/ld-bp/>

⁵⁹ The list of cultural institutions publishing their data in LOD format is very long and includes, among other, the British Museum, the Getty Institute, the Public Library of America.

⁶⁰ For a definition of the CIDOC-CRM ontology see subsequent paragraphs.

⁶¹ See Tudhope et al. 2011.

⁶² Cf. <http://hypermedia.research.southwales.ac.uk/kos/stellar/>

look at visualisations that are meant for a more general consumption and not for an audience of professionals. Information such as early archaeological reports have been included among the sources for the case study here presented, but they are only one of the types of documents that have been analysed. In addition, projects enabling semantic annotation of documents, seldom express information on the process of representation that takes place in the documents themselves. Lastly, nothing in STAR and STELLAR suggested an attention towards three-dimensional data.

The idea of using an ontology to document scholarly 3D visualisations was suggested by Niccolucci & D'Andrea as early as 2006. Their proposal was to extend the CIDOC-CRM ontology to document what they call “3D replicas of objects with cultural value”. Such a framework seemed to include, basically, a taxonomical description of the referent (i.e. type of pottery) and technological information about the 3D file (such as its value of opacity). While it is argued that 3D visualisation could be easily documented in XML using CIDOC-CRM's classes and properties, no thorough example of documentation was ever produced. Niccolucci mentions again the idea of a tailored extension of CIDOC-CRM for 3D visualisation in a paper about documentation standards in 2012, but admits that the project is still “currently under development by the author” (Niccolucci 2012:36). Besides the idea of mapping the documentation against CIDOC-CRM entities, which is not exposed in enough detail, what Niccolucci advocates is the introduction of an XML tag for philological notes. Using XML tags to annotate in free text a 3D model sounds like a useful feature, but it seems to only scratch the surface of the complex issues related to the visual representation of cultural heritage, its sources and documentation.

As this discussion shows, many scholars in digital and virtual archaeology have looked at CIDOC-CRM as the most natural choice when thinking of an ontology. In the words of Gill (2004):

The CIDOC Conceptual Reference Model is an object-oriented domain ontology for the interchange of rich and heterogeneous cultural heritage information from museums, libraries and archives. It is the evolutionary result of over two decades of collaborative international standards work by ICOM/CIDOC, the Comité International pour la Documentation of the International Council of Museums.

CIDOC-CRM became an ISO standard in 2006,⁶³ and this makes it a very reasonable choice when pursuing interoperability and standardization of data. In general, many new ontologies, especially those in the fields of art and cultural heritage, try to maximise their effectiveness, and compatibility mapping their elements against those of the CIDOC-CRM, or, even better, try to become themselves an official extension of the CIDOC-CRM. In spite of being born as a domain ontology for museum records, CIDOC-CRM has grown considerably in scope and complexity, now claiming that its framework can, potentially, model almost all kinds of information: from material objects to historical facts; from representation to intellectual process.⁶⁴ However, the completeness and richness of the CIDOC-CRM framework have their drawbacks. The many possibilities offered to model a concept, coupled with the long list of classes and properties that are part of the framework can be perceived as discouraging by a non-expert audience. As Sanders, ontologist of the Getty Institute, explains, completeness and usability of ontologies follow a curve where they initially grow together. But then, the usability dramatically decreases when more and more complexity is added. In his visual representation of this relationship, Sanders positions CIDOC-CRM at the 'rock bottom' of usability.⁶⁵

If the aim of a documentation for 3D visualisation is to become a widely adopted standard, then the ontology has to be approachable to both specialist and scholars that are not familiar with the linked data environment. A similar concern was expressed by the developers of the Generic Viewer (GV)⁶⁶ at the Center for Spatial Humanities in Mainz. The team had felt that the use of CIDOC-CRM was rejected even by researchers with some digital expertise. Therefore, they developed a simple interface⁶⁷ that enables one to annotate portions of a 3D environment by selecting among a small number of options via a drop down menu.⁶⁸ The annotations are then automatically exported as RDF triples. The intuitiveness of the GV interface pointed out the benefits of a simpler conceptual model. Unfortunately, the GV was built

⁶³ Cf.: http://www.iso.org/iso/catalogue_detail?csnumber=34424

⁶⁴ Cf. Doerr, M., & LeBoeuf, P. (2007)

⁶⁵ Keynote speech opening the Linked Pasts conference. Madrid 15-16 December 2016. A draft version of the speech can be found at <https://gist.github.com/azaro42/a7f9dd25ccf9e6679dd7f67bfed4e050>.

⁶⁶ Cf. Unold, M., & Lange, F. (2014). Relating texts to 3D-information: A generic software environment for Spatial Humanities. *Digital Humanities' 14 (DH 2014)*.

⁶⁷ Cf.: <http://ibr.spatialhumanities.de/viewer/>

⁶⁸ See further: <http://www.spatialhumanities.de/en/ibr/technology/genericviewer.html>

to import only point-cloud-generated 3D files (i.e. the results of digital imaging processes and not CAD modelling), so its application, even partially, to my research was not an available option. Moreover, the GV shows some of the limitations already encountered in other approaches, as all the annotations appear to be geometrically related to one single model and would hardly allow the comparison of different representations of the same referent.

Other qualities related to the nature of LOD seem worth mentioning, in the context of the present research. First, LOD are not hierarchically organised. This allows new information to be seamlessly added by the same or different authors, including conflicting or alternative views or statements. The structure of LOD also enables the connection to external digital documents and pieces of information (such as digital items in archives or bibliographical references)⁶⁹ instead of duplication of it. In this sense, it encourages the public and private repositories to produce and disseminate LOD about their items and make them available online, to be found and possibly linked to further items and related information by users, enriching both the value of the items in the collection and academic discourse around them. In particular, ontologies and linked data seem to be increasingly popular among museums, potentially leading to a very strong interaction between 3D representations of artefacts and the metadata about their material referents (or other related artefacts) held in museum collections.

Ontologies are often developed collaboratively and are, therefore, the result of a process of semantic negotiation that ensures a certain diversity of views. Definitions can be implemented and refined as well as deprecated. They can be mapped against other ontologies and be integrated and reused for other purposes. In general, the integration with LOD becomes a gateway for a scholarly 3D visualisation that is an open-ended, collaborative and multi-vocal product, or, better, a meta-product that allows us to compare the work of different researchers around the same entity. But the collaboration does not need to be limited to the same discipline or even within academia. Potentially, the use of LOD applied to 3D visualisation, coupled with a dedicated ontology, would contribute to create a dialogue between the educational and the private (or semiprivate) sector, allowing annotations of different nature to be associated to the same piece of 3D visualisation (Vitale 2016).

⁶⁹ A good examples of this policy is the Peripleo tool, developed by Pelagios Commons, to display connections about spatial and historical data. Peripleo shows connections between documents in different archives, but does not host a copy of such documents. See further: <http://pelagios.org/peripleo/map>

In other words, LOD seem a suitable tool to produce a synthetic, non verbose, not expensive and standardised documentation of 3D visualisations; and this documentation can, hypothetically, be enriched and refined by multiple authors as well as linked to bibliographical resources, information about material artefacts and alternative visualisations, either digital or pre-digital.

It is important to highlight that the documentation proposed here does not pertain to the technical aspect of the 3D model, besides a simple indication of the software that has been used to generate the 3D files. This choice might seem surprising, as recording the technical specifications of the file emerges as one of the main concerns, for example, in Niccolucci (2006 and 2012) and it is, indeed, a crucial piece of information that would dramatically enhance the sustainability and reproducibility of the file. However, there are two reasons why this aspect has been excluded from the discussion. The first is practical, as a perfectly functional ontology that covers technological aspects, the CRM-dig⁷⁰, has already been developed. It would have been redundant, and against the very idea of data recycling and reuse here advocated, to work on similar classes and properties. CRM-dig can also be potentially integrated with other ontologies, that have the same domain, but different scopes. The second reason is more methodological. Although fully recognising the importance of the technological component of the 3D file (that could be, paradoxically, considered its “material culture” component), I have chosen to focus primarily on documenting the process of representation and provenance of the sources.

1.4.2. A digital way to multivocality

Unlike traditional relational databases, LOD allow any user to make statements about anything that has a URI, including a 3D visualisation (or one of its components), a resource, an hypothesis or a piece of information that links them. Producing a statement in RDF and making it public can be (and often is) considered a proper publication (although in small scale), as, at least in an academic environment, each triple should refer to an author and a timestamp.⁷¹

Trying to express information about a digital three-dimensional representation of cultural heritage through standardised statements might seem a gross simplification. It echoes, in some respects, the larger problems met by historians when trying to produce, or analyse, historical

⁷⁰ See further: http://www.ics.forth.gr/isl/index_main.php?l=e&c=656

⁷¹ For the issues about attaching information about authorship and data to an RDF statement, see the paragraph on reification in Chapter Four.

narratives that are also simplifications of historical events. Not only is our vision of historical facts biased by the implicit or explicit motivations behind the narratives we choose, but, at a different level, the act itself of telling history is, according to Ankersmit (2001), intrinsically problematic, as history does not happen sequentially and does not follow a narrative-like, cause-effect structure. The act of building historical narratives is our way to simplify and grasp our past. Following Ankersmit's reasoning, we should only be allowed to state facts we are sure about, implying that all the connections between them are subjective and interpretative. However, as the historian points out, even just stating facts is far from being neutral. For example, two pieces of information one next to the other may make the reader infer chronological or causal connections between them, and subtly invite the reader to fill the gaps in the information in the way that is implicitly (although maybe unintentionally) suggested.

Using LOD to document a digital 3D visualisation is a process that seems to have much in common with that of stating facts in a historical narrative. In both cases, as Ankersmit's objection underlines, it not only means trying to simplify a much more complex process (in one case events, in the other the reasoning process of the researcher and their use of sources), but also to deal with what is not told but implied, voluntarily or otherwise, by the relationship between the stated facts. However, the non-hierarchical structure of the information makes the RDF statements autonomous. There are, of course, dependency relationships and implications in the modelling schema, and an organisation of classes and properties that is indeed loaded with meaning, but, in general, the pieces of information can be read independently. There is not a sequential way to read and access LOD, and it is difficult to predict what queries users will perform. Furthermore, in a context where the pool of linked data is open, there may be many authors introducing new statements, sometimes even conflicting ones. This means that none of the single authors can possibly control the narrative, even if one were to emerge from the data.

If it is true that there are no "exact" representations of ancient cultural heritage, it is also true that different readings and interpretations are seldom mutually exclusive, even in the mind of the same author. In its infancy, archaeology struggled so much to be considered a science that archaeologists felt compelled to show a positivistic attitude, to the point that references to the amount of speculation involved in archaeological theories were not welcome (Trigger 1989). As an inheritance of that age, archaeologists, including virtual ones, still appear reluctant to see subjectivity not as a curse but as added value. Considering a plurality of voices, or, to use

Hodder's (2013) words, considering multivocality not as something that undermines the scientific quality of the research but, on the contrary, as something that enriches it, is a crucial step in the understanding the potential of LOD as a documentation tool for 3D visualisation of cultural heritage. Even biased interpretations can be enlightening points of view, when declared and documented.

A documentation made of synthetic statements does not mean a documentation that uses an assertive style to give an illusion of certainty or objectivity. Quite to the contrary, the statements allowed in SCOTCH are almost exclusively about what sources the 3D authors have relied upon and why. In other words, the subject of the documentation is not how the represented object used to look like, but, more rigorously, what is the research process behind the visualisation of the object, and what other relevant information can be linked to it.

1.5. Research questions

In the light of the theoretical framework described in the previous pages, I have produced a proof of concept, featuring a double visualisation of the Pompeian Iseum. The visualisations are entirely documented in RDF triples, according to the new ontology drafted for this purpose. To explore the representation of the evolution of an ancient artefact, in both its materiality and its interpretations, the proof of concept features two independent but related models, one showing an hypothetical reconstruction of the Iseum at the time of the Vesuvius eruption in 79AD, and one showing an hypothetical reconstruction of how the Iseum might have looked like in the early years of the *Grand Tour*, according to contemporary secondary sources.

This work wants to test if the use of LOD, in the form of RDF triples and a simple, dedicated ontology can be an efficient way to document 3D visualisation of cultural heritage. Then, to explore and discuss what are the most common issues that are met during the process of modelling complex information about cultural heritage and its (digital and non digital) representations through a synthetic language and a fixed vocabulary. This thesis also aims to highlight the benefits of a standardised documentation of 3D visualisation for ancient cultural heritage, including improving its reliability, its value in the eyes of the scholarly community, its multi-disciplinarity, and its longevity.

I will argue that open, collaborative and multivocal digital documentation of 3D visualisation can facilitate a different approach to scholarly 3D visualisation: an approach that,

although envisioned by other scholars in the recent past, does not yet seem to be actively pursued by the community of practitioners. This thesis claims not only that documentation can be (and often is) more interesting than the 3D outcome itself, but also that it dramatically increases its value, its potential, and its impact when it is connected to the growing pool of open data about cultural heritage that is available online, in a process of mutual enrichment. One of the purposes of this research is to shift the attention from the final visual product to the process of representing historical places and objects, thus disclosing the potential of documented 3D visualisation as powerful tools to study both cultural heritage and the methodology to investigate it. Lastly, this research wants to stress how the goal of scholarly 3D visualisation should not be that of reproducing an historical artefact but to represent the fluid, sometimes inconsistent and always evolving knowledge about it.

Not having encountered a domain ontology that seemed able to deal in a meaningful and approachable way with the aspects of 3D visualisation I was focussing on, I have designed a simple ontology that partly re-uses previously existing properties, and partly creates new ones *ad hoc*. In the following chapters the case study will be presented, and its choice discussed and supported, along with the choice of the primary and secondary sources on which the visualisations themselves are based. Some historical and anthropological peculiarities of the site of Pompeii will be analysed in order to show how they have been modelled in the ontology framework. The rationale of the ontology and the conceptual model that shaped it will be presented and argued for. Each class and properties will be described as a single entity and in its relationship with other classes and properties.

This work is composed of a written component, that unravels the methodology and the rationale of the research; of two 3D models of the same ancient monument, their documentation in RDF, and the definitions of all the entities in the ontology. All the components contribute to the theoretical value of this research and only reach their potential when interacting with each other.

2. Proof of concept: methodology and rationale

The previous chapter presented the main issues related to the documentation of 3D visualisation of cultural heritage in academia, and proposed the use of Linked Open Data and a domain ontology as a new, efficient standard to document 3D data. Following on the research questions introduced, in this chapter I will focus on the proof of concept that I produced to test the documentation framework. In particular, the choice of case study will be analysed, and the ancient city of Pompeii will be presented as both the object of the documentation and one of the variables that shaped SCOTCH in its current form. The unique qualities of Pompeian documentation will be discussed, and used as an example of the variety and richness, but also inconsistency and unreliability that visual and written historical representation can reach. Lastly, this chapter will analyse the methodological guidelines that supported the development of SCOTCH and their rationale, before the ontology is discussed in more detail in Chapter Four.

2.1. Choice of case study: the Iseum in Pompeii

2.1.1. The many identities of Pompeii

The ancient city of Pompeii is a place that hardly needs an introduction. It has been extremely popular since its rediscovery in the Eighteenth century, and it is still a familiar component of the collective imagination (Hales & Paul 2011), thanks to countless mentions and representations in academic discourse as well as popular culture (Moormann 2015). Nonetheless, a short introduction may be useful in order to highlight the characteristics of the site that have driven the choice of Pompeii as a case study for this research, and that have posed some specific questions during the development of the proof of concept.

Pompeii was a Oscan city, fallen under Rome's influence in Fourth century BCE. It officially became a Roman colony in 80 BCE, when, after the unsuccessful rebellion of 89 BCE, the land and properties were given to Roman veterans as reward for their service. Although the Grand Tour rhetoric, as well as some contemporary cultural products,⁷² wanted to present Pompeii as a jewel city or an upper-class resort, archaeological evidence and historical records seem to suggest that, on the contrary, it was a fairly ordinary place. Apart from the infamous 59

⁷² Cf., for example, the trailer of the very popular movie Pompeii (2014), starting with a voiceover declaring "[Pompeii] was the jewel of our empire". Can be seen at <https://www.youtube.com/watch?v=6UqaCUAGCOK>

AD riot in the Amphitheatre involving the supporters of the rival Nucera,⁷³ that gained Pompeii a ten year ban from any public games, the city seems to have been renowned mostly for the tragic events that marked its history. The first was a quite violent earthquake, around 62 AD,⁷⁴ that damaged many of the city's buildings, and probably seriously compromised the whole economy. The event has been very strikingly portrayed in the bas relief found in the lararium of the House of Cecilius Iocundus. The second is the well known eruption of Mount Vesuvius,⁷⁵ that covered the city in ashes, allowing the place and its material culture to be preserved for almost two thousand years in exceptionally good conditions until it was rediscovered⁷⁶ in 1748. When the cities around Vesuvius were excavated, the amount and state of preservation of the finds were astonishing and unprecedented. News of the sites travelled all around Europe, and Pompeian landscapes and artefacts heavily influenced European artistic and cultural life in the subsequent decades (AAVV 2015), from fashion to home decor to music.

The discovery of Pompeii and Herculaneum happened under the reign of Charles of Bourbon (the future Charles III of Spain), who decided to consider everything found in the two archaeological sites as part of the Royal treasury and, therefore, his personal property. The strict policies he enabled around this wealth of ancient artefacts were probably influenced by the example set by his mother, Elisabetta Farnese. Elisabetta was a descendant of the Farnese Pope, Paul the Third. After the premature and unexpected death of a number of her male relatives, she found herself not only Duchess of Parma, but also the heiress of the first personal art collection owned by a Pope, the famous Farnese Collection. When she became the wife of Philip the V, Elisabetta saw that unique treasure of ancient artefacts as something that would bring prestige to the still young, but ambitious, Kingdom of Naples that they were ruling (Harris 2008, Moormann 2015). When Elisabetta and Philip moved to Spain as a new Royal couple, the Kingdom of Naples passed into the hands of their eldest son, Charles. Sharing his mother's views on art and antiquities, Charles managed to move the Parmesan branch of the collection to Naples. The lavish expenses devoted to the construction, in Caserta, of a

⁷³ The episode, and its consequences, are reported in Tacitus, *Annales*, XIV, 17. The riot is also famously depicted in a fresco, found in the House of Actius Anicetus and now on display in the Archaeological Museum of Naples.

⁷⁴ Cf.: De Carolis, E., & Patricelli, G. (2003).

⁷⁵ A moving account of the tragedy is famously given by Pliny the Younger many years after he witnessed event.

⁷⁶ Historical evidence points out that an ancient site in the area of Pompeii had been known at least since the 16th century, if not before. However, we will refer to 1748 as the date of the beginning of the excavations in Pompeii and 1738 for the beginning of the excavations in Herculaneum. Both under the direction of the Spanish military engineer Joaquin de Alcubierre

grandiose leisure palace inspired by Versailles,⁷⁷ and of a new building in Naples with the specific purpose of hosting all the antiquities in the family collection, from the inherited ones to those found during the excavations,⁷⁸ are a quite explicit clue to the importance given to pieces of ancient art as a status symbol by the Bourbon family. Access to the excavation, and to the artefacts on display in the Palace of Portici, was rigorously controlled (Leppmann 1968).

In the account of the Niccolò Marcello de Venuti:

*Il nostro Re si dimostra adesso geloso all'estremo di tutto, e già tutto si conserva, e si son fabbricate più stanze sotto le Logge Reali del Gran Palazzo di Napoli per situare (ma non sappiamo quando) il tutto con ordine (1749:106).*⁷⁹

A royal permit was required to be admitted to the sites, and it was only granted to established scholars, famous artists or visiting members of the European nobility. It was considered a privilege, and a glamorous experience (Jacobelli 2008). This proud, but also jealous, attitude towards the archaeological finds was perpetuated when the Kingdom of Naples was inherited by Charles's son, Ferdinand, who continued to fund the excavations, the study and records of the archaeology and the creation of infrastructure for the growing number of visitors, such as the circumvesuviana, the first railroad in Europe. Ferdinand even succeeded in moving the more substantial part of the Farnese collection from Rome to Naples, in the face of strong opposition from the Vatican.⁸⁰

When historical, political and economical events caused funds for the excavations to become less generous, and the operations faced a long period of interruption, the director of the scavi at the time, Giuseppe Fiorelli, suggested an unprecedented solution: to open the site not only to selected guests but to the general public, for a price (Jacobelli 2008). The idea has been an almost uninterrupted success ever since.

⁷⁷ The Palace of Caserta (Reggia di Caserta), designed by Italian architect Luigi Vanvitelli, built between 1752 and 1774 and now listed in the Unesco Heritage.

⁷⁸ The Palace of Portici, built between 1728 and 1742, was the first place where some of the Vesuvian artefacts could be admired.

⁷⁹ Our King has now become extremely jealous of everything, everything has to be stored, and he had more rooms built under the Logge Reali del Gran Palazzo di Napoli to arrange everything (but we still do not know when) in an orderly fashion.

⁸⁰ The collection is still almost entirely in Naples.

2.1.2 Popularity of Pompeii as archaeological site and tourist attraction

Since the beginning of the excavations in 1748, Pompeii has always been a very popular destination and has attracted a large and international public, from professional archaeologists to simple tourists (Hales and Paul 2011). Today, the site is still visited every year by an average of two million people from all over the world⁸¹ and its popularity can be seen as a proof of its relevance to a very large and diverse audience.⁸² As a result, a considerable amount of written and visual, academic and artistic, public and private documents have been produced about this place. In Hales and Paul's (2011) words:

[...] Pompeii and—to a lesser extent—its neighbour Herculaneum have become increasingly accessible to widespread audiences, through visits to the site, museum exhibits, and through media such as books or film. [...] Its success demonstrates the appeal of the unrivalled access to the past that Pompeii seems to offer and its tremendous imaginative potential. As a site where we can interrogate the intersections between past and present, Pompeii provides an outstanding opportunity to contribute to our understanding of modern reception of the ancient past, through the rich body of engagements that it has inspired. (2011:1)

Although it is certainly not the only ancient city that can be still seen and visited, some very specific characteristics make Pompeii a unique attraction. One seems to be the emotional response that its history solicits, or, better, the narrative around those historical events. The potential of Pompeii (and Herculaneum) is not simply due to their being Roman towns. Compared to other rediscovered ancient cities that had been abandoned for practical reasons and then slowly decayed, Pompeii has a much more tragic history. According to Baum, 'Pompeian remains might be categorised as ruins of suddenness, rather than ruins of duration' (2011:45). The idea of a city destroyed in one day; a catastrophe with no survivors that the volcano has—at the same time—caused and preserved, has a huge emotional impact that has made Pompeii almost archetypal (Lazer 2009).

⁸¹ Data from Azienda Autonoma di Cura, Soggiorno a Turismo di Pompei. Ufficio Statistica. Cfr. <http://www.pompeisites.org/Sezione.jsp?idSezione=9>

⁸² Also, cf. the data about the successful exhibition *Life and Death in Pompeii and Herculaneum* in London (March-September 2013), at the British Museum.

Another unique feature that makes Pompeii so appealing to the public, and such a good inspiration for works of fiction, are the plaster casts of the human bodies. The technique, developed in 1860 by Giuseppe Fiorelli⁸³ and gradually improved, allows visitors to see the shape of the victims' bodies as they looked when they died, after filling with plaster the void that the bodies (now decomposed) left in the ashes and debris. The volumes obtained are sometimes very detailed and often quite moving. The Garden of the Fugitives, where the casts of a dozen people killed by the eruption while they were seeking shelter are displayed, is one of the most popular places in Pompeii. Part human remains, part crafted artefacts, the plaster casts of the victims, or, as Dwyer (2010) calls them, 'the living statues', offer to visitors the uncommon experience of witnessing the last moments of people tragically disappeared many years ago. As Lazer (2009) points out, finding human victims next to items from everyday life became an unmissable opportunity for writers, members of the public but also professional archaeologists to imagine relatable life stories and to experience an emotional connection.

The reasons behind Pompeii and Herculaneum's everlasting fame are not especially relevant to this research, that is more concerned with the consequences of such popularity, i.e. the large amount of data about Pompeian findings, houses, inscriptions that have been produced, studied and discussed. Many artists and intellectuals, over two centuries, have visited the place and left a testimony of their impressions and thoughts, sometimes directly in journals and reports, sometimes indirectly in works of art (Blix 2008, Hales and Paul 2011). Besides being investigated by a wide number of archaeologists, ancient historians and classicists, Pompeii has also been object of interest and source of inspiration to artists such as Goethe, who became a fervent promoter of both the site and the museum, de Staël, who set in Pompeii large parts of her most famous novel *Corinne*, or Stendhal, who, apparently, was so charmed by the ruins that returned to Pompeii seven times during the same trip:

Ce que j'ai vu de plus curieux dans mon voyage c'est Pompéi; on se sent transporté dans l'Antiquité j'y suis retournée aujourd'hui pour la septième fois. (Stendhal 1817. Cited in Moormann 2015:127).⁸⁴

⁸³ Cf. Fiorelli's *Pompeianarum Antiquitatum Historia*.

⁸⁴ The most curious thing I have seen in my journey is Pompeii: one feel transported to the Ancient times. I went again today for the seventh time.

But also Freud, Gautier, Nerval, Leopardi, only to mention a few, were all somehow struck by the uniqueness of the place.

In this sense, Pompeii offers an amount of complex and often interlinked information that is not to be assumed when dealing with other archaeological sites. In addition, the popularity that the place still holds among contemporary scholars and tourists⁸⁵ has made Pompeii a repeated choice for digitisation projects. The number of digital reproductions of Pompeian documents available online is, again, exceptional. This abundance is probably partly caused by its relevance to the general public, and partly by sheer numbers. Publications on Pompeii were so common, that many libraries and collections that are now digitising and making available their materials are likely to own something related to Pompeii.

As mentioned in the previous chapter, there is always a large component of speculation and interpretation of material clues involved in both traditional and virtual archaeological thought. This is even truer for Pompeii. When studying Pompeii, in fact, archaeologists have to deal with an additional level of uncertainty, due to the peculiar history of the place. The pyroclastic events that destroyed the city also caused the artefacts to be scattered by the violence of natural forces. As a consequence, it becomes sometimes difficult, and even more open to speculation than the average, to state a sure connection between an ancient Pompeian object and its exact place of finding. Furthermore, the earthquake of 62 AD had possibly caused many buildings to be abandoned or repurposed, generating oddities and inconsistencies with the canonical use of private and public spaces in Roman towns during the same period. To stress even more the aura of uncertainty around Pompeian archaeology, older textual evidence, such as excavation records, can only be partially trusted as a source of information: the habit of staging the discovery of artefacts to please prestigious guests was very popular in the first decades of the excavations and caused an unrecorded movement of artefacts and possibly a number of fabricated and contradictory entries (Jacobelli 2010).

If this situation might sound discouraging for researchers trying to study the material remains and related records, it also stresses how archaeological readings are always partial and biased and, sometimes, do not agree with each other. Such an academic panorama makes

⁸⁵ Books and movies about Pompeii continue to be successfully published, and it is not uncommon that they become best sellers or blockbusters. Just looking at the anglophone market, cf., for example, Mary Beard's book (2010) and BBC series (2011) about Pompeii, and the already mentioned 2015 movie *Pompeii*.

a documentation and comparison of sources, like that enabled by the SCOTCH framework, even more interesting (and needed) than it would be in a scenario where documents, records, and the scholarship around them tend to be unanimous.

2.1.3. The evolution of Pompeii in its materiality and in its interpretations

Pompeii has been changing continuously in the past two hundred and fifty years. In the words of Gardner Coates and Seydl (2007:1)

While their completeness has led to the persistent impression of the recovered cities as a transparent window into the classical past, Herculaneum and Pompeii did not emerge from the earth fully formed like Minerva from the head of Jupiter. On the contrary, the sites have been in constant flux, from the moment in 1709 when the first antiquities were removed from a well shaft in Resina to the present-day excavations. Scholarship on the finds has been equally fluid, as drastic changes in method followed each other in rapid succession and even at times contentiously coexisted. Each layer of interpretation has melded into the next, leaving a complex trail of discovery, response, and exploitation. At the same time, the objects and environments have been decontextualised, reshaped, and, in some cases, lost altogether.

A comparative look at the visual documentation of different moments of the Pompeian excavation process shows how the idea of the Roman city as a sort of Sleeping Beauty's castle (Lazer:2009) is just a a very popular (and effective) narrative. Since the beginnings of the excavations, buildings have been restored, often in a way that makes it difficult to tell original artefacts from modern repairs, scenes have been arranged for the sake of the touristic gaze, gardens have appeared and disappeared, facilities have been built and walking patterns changed. According to Mary Beard, Pompeii is as much as a fake, modern construction as it is an ancient Roman town.

It exists in that strange no-man's land between ruin and reconstruction, antiquity and the present day. For a start, much of it is heavily restored, and not just after the wartime bomb damage. It comes as quite a shock to look at photographs of the buildings as

they were excavated, and to see what a poor state most of them were found. Some, it is true, have been left just like that. But others have been smartened up, their walls patched and rebuilt, to hold new roofs - primarily to protect the structure and decoration, but often taken by visitors for miraculous survivals from the Roman period. (Beard 2008:19-20)

Pompeii's very long history as a tourist attraction and object of study, has two direct consequences on this research. In the first place, it offers the opportunity to compare different visual and verbal records of the same building, and, sometimes, of the same single artefact. Therefore, it allows us to examine the material evolution of the object, to track its declared or undeclared modifications and restorations, to investigate disappeared or removed elements, but also to look at popularity trends through the analysis of touristic paths and accounts. Second, on a more theoretical level, records of different moments of the history of the site itself support the idea that cultural heritage is a "living object" that ages, evolves and adapts to the material and nonmaterial context.

The many visual and verbal records of Pompeian artefacts enable us today to retrieve information about elements and details that no longer exist in their materiality. In this respect, they are an invaluable resource for visual representation of historical objects. At the same time, they offer important clues about the interpretation process, and the different cultural trends that flourished through time. Thus, if their documentary value is to be recognised, they also should not be mistaken for objective evidence, but treated as mediated representations of the past.

Pompeian documentation, from excavation records to guide books and visual reproductions, is so rich and diverse that it can be considered a field of study in itself (Lyons and Reed, 2007). Even a quick overview gives a taste of how many different variables can, and usually do, influence the understanding, study and representation of ancient cultural heritage in general, and Pompeii in particular. Among the many examples in Pompeian studies, a very straightforward one can be found looking at the documentation of a fresco in the House of Orpheus. The larger than life painting on the back wall of the *viridarium* represents Orpheus playing the lyre, surrounded by various animals. The fresco has been reproduced in at least two major publications in the Nineteenth Century. The first image, dated 1854, is by Fausto Niccolini, and appears in *Le Case ed i Monumenti di Pompei: disegnati e descritti* (III. 55). The

second drawing, published in 1878, is by Emil Presuhn, in *Les Décorations Murales de Pompéi* (Ill. 56). When compared, the two images appear to be consistent in the representation of the main layout of the Pompeian fresco, but there are many details that are, on the contrary, strikingly different. Looking at the top right corner of the central panel, for example, the lion and the other big feline portrayed by Niccolini, become an elephant and a hippopotamus in Presuhn's eyes. Also, the colours and the entire landscape of the area surrounding the animals appear to be quite dissimilar: the green and refreshing environment, crossed by a lively water stream, painted by Niccolini is completely absent in Presuhn's version, giving way to a much dryer and earthy-coloured landscape.

The first hypothesis that might be offered to account for this discrepancy between the representations, is that the fresco degraded quickly during the twenty four years separating the two publications, making it more difficult for Presuhn to see and represent the most damaged areas of the painting. It is not uncommon in the history of Pompeii and Herculaneum that frescos left in situ faded surprisingly quickly because of the exposure to natural elements. The fate of the Amphitheater's wall decoration, which completely disappeared after a single, harsh winter, is reported by Fiorelli. However, there are other areas of the fresco that, on the contrary, look richer in Presuhn's drawing than in Niccolini's older one, such as the illusory garden on both sides of the painting that, in Presuhn's version, displays more, and more detailed, birds. Due to the conditions of the original fresco (Ill. 54), it is now impossible to state which drawing is the closest to the Roman one. The comparison between the two images points out the complex nature of visual representation, and its delicate role in the study of ancient (and often disappeared) artefacts.

Among the many variables that may have influenced the different look of the work of these two authors, their different style is probably one of the most apparent, possibly due to the different nationality of the artists and the twenty four years gap between their publications. Another of the elements that often impact on representation is the technical and technological component. Looking at the two published drawings, the very bright colours in Niccolini's image and a certain flatness in both (but especially in Presuhn's one) are probably due to the printing techniques of the time more than an expressive choice. Personal skills and taste, available time, motivation, retribution are only a few of the variables that can be listed to give an idea of how different representations of the same piece of cultural heritage can be. This very large amount

of data about Pompeian buildings and artefacts allows us to consider variant hypotheses and alternative restorations for the same object, promoting the idea that visualisations are not meant to show the artefacts “as they were”, but to reflect on how they might have looked and how they have been perceived and represented during their history.

Comparing views of the Vesuvian city and its artefacts is not only a matter of multiple (and sometimes mutually exclusive) restoration hypotheses, but also concerns the different cultural approaches to the same place or object. The variety of groups of people—different in gender, social class, national provenance, education—that dealt in one way or another with Pompeii or one of its parts, offers the opportunity to highlight processes of interpretation and appropriation, national (and nationalist) rhetoric and dominant narratives in general.

The abundance of visual and textual records of Pompeian artefacts sheds light on the cultural implications that are intertwined with every process of representation of antiquities. Unlike the case of the Orpheus fresco just discussed, many other illustrations and reports depict still existing objects, allowing us to compare the copies with the original artefacts, pointing out how discourse on visualisation needs to look beyond the materiality of the represented object. In the history of depictions of Pompeii and Herculaneum, an important role seems to be played by expectations. As Blix (2008) reminds us, during the Eighteenth century, the study of the ancient world was still almost entirely based on the analysis of literary sources. Not only was archeology not yet a discipline, but its very concept was still unknown. The interest in material finds and ancient objects was regarded as an hobby for collectors, a little extravaganza for rich people and a source of income for local dealers. Relying only on literature, and, often, on a particular kind of literature that was the official one, the idea of the past, and especially that of Roman cities, was generally rather grand and monumental. This myth of Roman times as a golden age of strength, wisdom and equilibrium was probably one of the causes of the general disappointment of the first visitors to the excavations, but, also, of the visual expectations of the artists of the time. Leppmann very effectively describes the first impression of Pompeii experienced by the early visitors as ‘telescoped image’ (1968:84) of the city, and reminds how often terms such as “smallness’ ... narrow ... doll’s house ... mummified ... curious and rather disagreeable” (1968:84) occurred in the first accounts.

If it is quite common to read unimpressed, and even worried, comments in the first reports on Pompeii and Herculaneum, it is nonetheless true that many accounts targeting a wider public

actually kept promoting Pompeii as a place consistent, in its spirit and look, with the popular idea of a magnificent, classical city. Even Goethe, whose first impression of Pompeii was not so favourable, will defend the frescoes of the Vesuvian houses as very fine pieces of art. Talking of the so-called Sitting Muse (Ill. 64), he would say that 'Never was composure and consideration expressed with more liveliness and grace than in this figure'.⁸⁶ Or, describing the colours in the so-called Nymphs' Oracle (Ill. 65), that 'All colours enhance one another while also remaining secondary to the skin colours. This creates for the entire work a magical appeal, a delight to the eye denied by most new products of art'.⁸⁷ For completeness, it should be noticed that Goethe's enthusiastic words were written not immediately after his visit to Pompeii, but many years later, as a commentary to a published sets of reproductions of the Pompeian frescoes by Wilhelm Ternite and Wilhelm Zahn that look rather embellished and certainly closer to the Neoclassical taste than the actual classical ones.

The link suggested by personalities like Goethe and other enthusiasts between Pompeian art and Renaissance paintings or Greek statues, along with the literature-based knowledge of ancient times, produced a certain hype around Pompeii and its artefacts. So, it is not surprising to discover that eighteenth- and nineteenth-century artists often adjusted and beautified their copies of Pompeian houses and decorations. According to an anonymous witness of the first years of the excavations:

The king is now employing a person to take drawings of all the statues and principal paintings; with an intent to publish them, together with an account of Herculaneum. The statues cannot be made to appear more beautiful than they really are: but the writer imagines the world will be vastly deceived with regard to the paintings. For the man is a very nice drawer; and has also managed the colouring to advantage; so that he has made exceedingly pretty things, from originals, which are miserable daubings. The company having seen the drawing first, were extremely disappointed, when they afterwards came to view the originals. (cited in Mattusch 2011:13)

⁸⁶ Goethe (1999:376). Cited in Fitton 2011:29.

⁸⁷ Goethe (1999:378). Cited in Fitton 2011:30.

The phenomenon is especially visible in the representations of human bodies. For example, in the copy of the fresco depicting Hercules and Telephus (Ill. 66) drawn by Élie-Honoré Montagny in 1864, all the proportions of the characters seem to have been slightly corrected, according to the contemporary visual standards (Ill. 67). The effect is especially apparent in the representation of little Telephus, in the left bottom corner. Unsurprisingly, the “regularisation” of the image increases at each passage of a new hand. Cochin’s representation of the fresco (Ill. 67), which is a copy of Montagny’s drawing instead of a copy of the Herculaneum artefact, can be hardly considered representative of the original piece.

An expectation of symmetry and perfection was already projected onto Roman remains by Renaissance artists and architects, to the point that some architectural plans of ancient buildings, for the purpose of study or even restoration, offer a quite blatantly “corrected” view of the original building (Jones 2003). But, in addition to the weight of the imagined ideal type that was projected on all Roman cities and buildings, the peculiarities of Pompeii and Herculaneum make the documentation and representations of the artefacts even more subjective on the one hand, and more interesting as objects of study themselves on the other.

If cultural heritage sites cannot be fully understood without considering the non-material component of their identities, this is even truer for Pompeii. Its fame has made it a narrative topos as much as a real place (Leppmann 1968). But Pompeii was not always, or only, the canvas on which to project Neoclassical ideals. The appeal of the place evolved with the evolution of cultural trends (Leppman 1968, Blix 2009, Moormann 2015). Romantic artists and tourists, on the contrary, enjoyed the desolation of the ruins and the ubiquitous sense of loss and death (Caracciolo in AAVV 2015). Pompeii was inspiring in its never-ending agony. Unsurprisingly, the tourist guides started referring to it as “The City of the Dead” (Zimmermann 2009). The sense of danger inspired by the looming silhouette of the Vesuvius became a component of the charm of the place and a reminder of the caducity of life, like a sort of fanciful *memento mori*. But Pompeii was also, in Christian narratives, a place sinfully corrupted by lust and self indulgence that rightly met with the anger of almighty God. A new Sodom and Gomorrah that was justly destroyed by divine intervention, through the purifying fire of the volcano. In more modern times, also due to the reflections on the symbolic role of the city by Sigmund Freud in his essay *Delusion and Dream in Jensen’s Gradiva* (1907), Pompeii became

a metaphor for the unconscious, a trigger for the hidden feelings and passions that are as “buried” as the buildings, objects and people in the ancient city.

The different views of the city, or, in a way, its many identities, can be seen also in the different purposes of the various people that visited it. Pompeii was a useful source of antiquities and paid work for many of the locals, it was a relic of the past with precious insights about the everyday lives in Roman times for archaeologists and historians, an unprecedented window on ancient art, a place inhabited by ghosts where the “aura” of the tragedy could still be felt, and even a gate to unresolved passions and fears. The different lives of the city crossed as well as the people involved in them. And, sometimes, they clashed. One of the most colourful examples of the many Pompeiis coexisting in the different uses and perceptions of the city, can be found in the accounts of the perplexed reactions of nineteenth-century foreign visitors discovering that some locals were slowly repopulating Pompeii and using the ruins as private houses. In an article on *Household Words* in 1852⁸⁸ the author comments on the strange view of laundry hung up to dry among the ruined houses (Zimmermann 2009). Northern European and American tourists were often both fascinated and terrified not only by the archaeological site and the volcano, but by the Neapolitans themselves, perceived as wild, unpredictable and too intense. The foreigners, on the other hand, were seen as gullible and naive, but also as a welcome source of income. The conflict is, for example, very well depicted in Roberto Rossellini’s movie *A Journey to Italy*.⁸⁹

To include interpretations of places into their digital representation, links to the descriptions in written sources have been attached to the spatial elements in the proof of concept via LOD. Mainly due to their availability in digital format, the written sources consulted and included in the documentation often belong to the same macro socio-cultural group of white, male, affluent, highly educated Northern Europeans. Therefore, the interpretations are not nearly as diverse and multivocal as the research would have hoped. However, I believe that setting up and discussing the methodology, will make possible for other researchers to build on top of this proof of concept, and add, later on, less easily available or not yet digitised resources.

⁸⁸ Uncredited but attributed to John Delaware Lewis. Cited in Zimmermann 2009:111.

⁸⁹ *Viaggio in Italia*, 1954.

2.1.4. The Iseum in its depictions

The sacred area of the Iseum in Pompeii, situated at the back of the Large Theatre, was excavated in 1765 and was, since the beginning, the object of special attention (Beard 2008). The sacred complex is composed by a prostyle tetrastyle temple, a small Purgatorium with an underground space, an ekklesiasterion, an irregularly shaped sacrarium, and three cubicula, probably for private use and portico. The main temple was, by far, the building that attracted the most attention. It is not uncommon that the whole complex is named simply “Temple of Isis” in many of the historical sources. In this work, however, the label “Temple of Isis” will be used more specifically to identify the tetrastyle temple, and the label “Iseum” will be used to refer to the sacred area in its entirety, as identified by the numbers VIII. 7. 28 according to Fiorelli’s standard naming convention.

The Iseum appears to have been lavishly restored after the 62AD earthquake. As the inscription at the entrance tells,⁹⁰ the restoration was paid for by the wealthy Popidii family, and their generosity granted access to the city council to Celsinus at the exceptionally young age of six years. When excavated, the place still had most of its decoration in place and well preserved, including frescoed walls, several statues and inscriptions (Bragantini, Dickmann & Sampaolo 1998). A number of ritual objects and lamps were also found, along with the remains of two human bodies.⁹¹

As various sources attest (Bragantini, Dickmann & Sampaolo 1998; De Caro 1992), the Iseum is the best recorded architectural complex in the whole of Pompeii. The completeness and variety of its documentation is exceptional, even for the high standards set by the Royal Family in the early years of the excavations. The place received the special attention of Francisco La Vega, director of the excavations from 1780 to 1797, who ordered a full documentation of the place, including the areas usually neglected, and the frescoes that were not considered particularly valuable, such as those adorning the area known as Sacrarium. According to Alonso and Luzon (in AAVV 2015), the military education of the first directors of the excavations—Alcubierre, Weber and La Vega himself—influenced the tone of the documentation, and contributed to make it detailed, rigorous and complete. Not only did La Vega supervise the reproduction of the frescoes by other professionals, but he was himself a

⁹⁰ « N. Popidius N. f. Celsinus aedem Isidis terrae motu conlapsam a fundamento p.s. restituit; hunc decuriones ob liberalitatem, cum esset annorum sexs, ordini suo gratis adlegerunt »

⁹¹ See further: *Pompeianarum antiquitatum historia*, vol. 1, p.164

keen artist, and produced a number of insightful and precise scale drawings (for example, Ill. 10, Ill. 11 or Ill. 12).

As De Caro (1992) reports, the Iseum was the first example found of Egyptian (or, better, Egyptianising) art in the Roman world, and started an entire Egyptian-inspired trend in architecture and fashion in Western Europe during the Napoleonic era. Part of the Iseum's popularity was due to its mysterious and exotic aura (Baum 2011), part to the influence of Bulwer Lytton's extremely popular novel *The last days of Pompeii*, where the Temple appears as one of the main settings.⁹² Its appearance caught the interest of architects such as Francesco Piranesi and John Soane, and the temple is featured in countless written and visual accounts of visits to Pompeii. It is practically impossible to find an old guide book to Pompeii that does not include the Iseum among the highlights and the "must see" of the archaeological site. From the point of view of the interpretations, the Iseum thus appears especially rich, from at least two perspectives. The first is that its popularity, and its presence in both academic and popular literature, generated numerous and diverse documents featuring it, from the years of the excavation to today. The second is that, although looking at a Roman architectural complex, the cult of the goddess had been imported from the East into the Italian peninsula. This "encounter" generates multiple and intertwined layers of interpretations. The architecture, the decoration and the ritual artefacts all show an interesting combination of Roman and Egyptian traits or, better, they portray the projection of a Roman reading of Egyptian culture and rites (Ezquerro 2008). The multifaceted identity of the place is effectively exemplified by some of the objects found there. A number of traditional-looking Egyptian statuettes, for example, are carved from local stone, creating an odd feeling of cultural contamination. But the most telling findings are the two inscriptions found at the sides of the staircase of the main temple: the marble slabs are covered in Egyptian hieroglyphs or, more precisely, in hieroglyphic-looking signs that, according to modern archaeologists, bore no meaning. This suggests that the use of those inscription was not to deliver a textual message, but to communicate a sense of "Egyptianess" to a crowd that although able to identify hieroglyphs as Egyptian, was not able to understand the difference between real and mock ones.

Another reason that made the Iseum an appropriate choice for this proof of concept are the artefacts found there. They constitute one of the largest and more consistent collections in

⁹² In particular, it is the place where the Isis priest Arbaces, the villain of the story, plots his evil plans.

the Archaeological Museum of Naples (Sampaolo 1992), and are exhibited (mostly) together in a dedicated area.⁹³ Before all the artefacts were moved to the Portici Museum⁹⁴ and the frescoes stripped away, the walls of the Iseum were recorded by a group of professional draughtsmen and engravers hired by the Royal Family, who produced detailed graphic documentation⁹⁵ (Elia 1941). Some of those verbal and visual historical records are now the only surviving information about some disappeared elements of the Iseum, such as the elegant floor mosaics of the main temple⁹⁶ or the positions of the many cult statues⁹⁷. Under this perspective, the Iseum makes a good case for a digital unification that virtually reunites dispersed and even lost items. In addition, the presence in the Museum of a scale model of the the Iseum offers both a comparison for alternative restoration hypotheses and an opportunity to highlight the differences between digital and non-digital 3D visualisations.⁹⁸

The attempt at representing Pompeii consistently with the audience's expectations, that has been discussed in the previous paragraphs, can be seen very clearly in the early reproductions of the Iseum. A common rhetorical device, for example, was to remove entire large elements (more often the east side of the portico colonnade) from the view, artificially enlarging the space and creating room for displaying human figures performing various activities (as can be seen, for example in Ill. 33, Ill.34 and Ill. 2, among others). It is not possible to say if such distorted representations of the landscape are the consequences of a conscious or subconscious process; if they express a stylistic choice or an explicit support of the Bourbons' political agenda. Generally speaking, the first representations of the Iseum tend to show the place significantly wider and more majestic than it is. The crowded processions of Isiac cultists, for example, imagined and drawn by Desprez (Ill. 3) and published in Saint Non's *Voyage*, are not only more imaginative than historically grounded, but they are actually very

⁹³ The Sale Isiache.

⁹⁴ And, years later, in the National Archaeological Museum in Naples.

⁹⁵ As Elia (1941) and Sampaolo (1992) remark, the documentation, although stylistically excellent, is controversial as it does not appear completely faithful to the actual fragments held by the Museum of Naples. This discrepancy has been discussed in my Masters dissertation and will be further analysed in a subsequent chapter.

⁹⁶ The pattern and the dimensions had been recorded by Francesco La Vega in his drawings and then by Francesco Piranesi in *Antiquites de la Grande Grece: Tome II*. Paris 1804.

⁹⁷ Recorded, among others, by Fausto and Felice Niccolini, *Le case ed i monumenti di Pompei: Volume Primo*. Napoli 1854

⁹⁸ A line of investigation that has not been pursued during this research.

unlikely (when not altogether impossible) to have ever happened in the material space of the Iseum.

Being so difficult to obtain permission to visit and, even more so, to draw Pompeian ruins (Sampaolo 2015), the first few images of the Iseum were copied and republished many times (Lyon and Reed 2007), becoming more and more fixed in the public imagination. From this perspective, it is interesting to note that the advent of photography did not change much in the representation of the Iseum, and, in particular, of the main Temple. The first pictures (for example Ill. 42 and Ill. 43) in fact, are taken from a point of view that excludes the east side of the portico colonnade, distorting the perspective in order to make the space look wider. It is not unlikely that the photographers were trying to conform their images to the expectations of the public; expectations that had been shaped by decades of reproductions of the same, realistic in style but unfaithful to the actual place, illustrations. Therefore, the Iseum seemed, by its very nature, an ideal example to show how different interpretations can be attached to the same artefact, and how documentation should be considered both a source of information and a narrative influenced by several cultural, historical and material variables.

2.2. Modelling the Iseum in 3D

This proof of concept addresses the issue of time and the constant evolution of cultural heritage visualising two different moments of the life of the Iseum, and connecting the representations. The first model represents an hypothetical restoration of how the Iseum might have looked like after the post earthquake refurbishment. The second one represents the site as it appeared to the first visitors, in the early years after the excavations, according to the contemporary visual and verbal documentation. The two 3D environments, showing the two most commonly depicted moments of the life of Iseum, are entirely independent from each other, but they are both linked, via LOD, to the same real space that they represent (the Iseum in Pompeii).

The two models, that will be indicated as Iseum79 (named after the year of the eruption) and IseumGT (named after the initials of “Grand Tour”) in this discussion, share the same plan, designed according to my own hand measurements of the site integrated with information derived from secondary sources. The first hand measurements have been collected and made available on Flickr. Some of them have been edited, some others have been purposely left in

the form of handwritten documents, to underline the variety of sources that have been consulted (and produced) during the process of modelling the two versions of the Iseum.

The status of almost all the architectural elements has certainly changed between the two represented moments. The absence of the plastering on the walls, and of the original floors alone make the volume of the ruins inevitably different from those of the building when it was in use. However, the elements in common have often been assumed to be identical for simplicity. In the virtual restoration, the former heights will be calculated starting from the known measurements and applying canonical architectural standards, such as the one described in Vitruvius, and comparing them against the work of other, past and present, classicists and architects. For the representation of the place during the years of the Grand Tour, it is not possible to know how high the elements used to be when they were first uncovered. In the IseumGT model, therefore, an approximation of the heights of the elements will be derived from the visual analysis of secondary sources.

The aim of this approach is to give an idea, through 3D representations that are linked to each other as well as to previous documentation, of how much the place has changed. The evolution of the Iseum does not pertain simply the period between the moment it was destroyed by the eruption in 79 AD and the moment it was found, but, also, how much it has changed (and it is still changing) in its history as an archaeological site, from the moment it was found to the present day. In a chronological perspective (or, better, in a biographic one), many different moments can be added to an hypothetical timeline of the Iseum, by the same author or by different ones. For example, it could be interesting to investigate how the Iseum used to look before the 62 AD earthquake and the subsequent restoration.

2.2.1 Aims of the 3D visualisation of the Iseum

The purpose of this proof of concept is neither to experiment with emerging 3D modelling techniques nor to test new archaeological theories about the original look of the Iseum. The aim of this research is to test if a synthetic, digital documentation of the 3D representation of a complex space, like a piece of ancient cultural heritage, is not only possible but also useful and enriching. In this sense, my visualisations do not suggest any new hypotheses about the layout and features of the Iseum in AD 79 or at the time of the excavations. This approach is reflected in the choice of the documents used as sources and references, i.e. the mostly widely accepted

and mainstream interpretations of the Iseum and its artefacts. However, although accuracy has been considered paramount, occasionally the variety of sources has been pursued for its own sake, to better test the potential of the documentation framework.

2.2.2 Rendering Style of the 3D visualisation

One of the first matters to consider before starting the modelling process was the graphic style to be adopted. The latest versions of the most popular CAD software packages used in both architectural and video-game development contexts, such as 3DS Max, Maya and Cinema4D allow, relatively cheaply and easily, the production of high quality realistic renderings, with pleasant texturing and precise lightings.⁹⁹ Visualisations seeking such an aesthetic are successful in appealing the audience at a first glance, but less effective in delivering information: they tend to be distracting (shifting the attention to the technical quality of the representation) and overwhelming for the user (Champion and Dave 2007). If images have generally a stronger inertial power than words (James 1997), realistic images are even more perceived as «true» and «faithful to reality», when, paradoxically, ‘the more precise and detailed the drawing, the more convincing it is - but the more unflagged guesses it contains’ (James 1997:26). A reconstruction featuring a realistic graphic style is likely to be seen as the only possible reconstruction or even the only correct one. The necessarily hypothetical nature of visualisations of ancient heritage (Baker 2012) is hidden from the eyes of the viewer. On the other hand, deliberately simplified graphics can be disappointing for the audience if they compare academic outcomes with the luxurious reconstructions¹⁰⁰ or expensive special effects showed off in sophisticated video games and other audiovisual popular products¹⁰¹ (Favro 2006).

Researchers developing 3D visualisations need to find a balance, and experiment with graphic solutions to create an outcome that is, at the same time, accurate, transparent and reasonably appealing. As James warns:

⁹⁹ Cf., for example, 3DS Max customer showcase at <http://www.autodesk.co.uk/adsk/servlet/pc/index?siteID=452932&id=21316114>, Cinema4D user gallery at <http://www.maxon.net/gallery.html>.

¹⁰⁰ For example the *Assassin's Creed* series by UbiSoft.

¹⁰¹ Such as the movie *The Gladiator*, the BBC TV series *Rome* and the HBO TV series *Spartacus*.

A misleading image may become the kind of idée fixe which inhibits re-interpretation and new perspective. (1997:26)

This commitment should be reflected not only in a transparent methodology, but also in the choice of an appropriate graphic style that conveys information without communicating a misleading sense of realism and/or certainty. For these reasons, the graphic style of the models here presented has been purposely kept fairly simple. From a geometric point of view, only the main masses of the Iseum have been modelled, leaving architectural details such as the capitals, or the stucco decorations more suggested than actually designed. The Iseum79 model has been left untextured and rendered using one of the built-in 3DSMax graphic rendering options. This choice is meant to stress the hypothetical and work-in-progress nature of the visualisation itself. The IseumGT model has been textured with images derived from the eighteenth- and nineteenth-century visual records, when available, and left simply gray when the appropriate documentation could not be found or was not suitable. The choice and editing of the textures will be described in more detail in the following chapter.

Another aspect of the modelling that is worth discussing briefly are the boundaries of the representation. A 3D visualisation is a model, and, as such, it aims at reproducing selected qualities of reality, for simulation and study purposes (McCarty 2003). Nonetheless, what should be included in a 3D visualisation of cultural heritage is a question that does not have an easy answer. How much of the surrounding landscape, how many of the connected buildings and streets should be part of the model? The issue is not only quantitative but also qualitative: should buildings and objects show signs of use, damage and dirt, or look clean and intact? On the one hand, visualisations are abstractions, and, as such, should be recognisable as simplified representations of reality (Hermon 2008). On the other, years of this visual tradition—that long predates digital technologies—have disseminated a sanitised idea of the past, in particular of the classical period, that is quite unrealistic; the same visual expectation that is, for example, behind the several subsequent “washes” of the Parthenon Marbles in the British Museum (Jenkins 2001). More than the actual material buildings or artefacts, the visualised ones look like Platonic ideas, things that have never been touched by a human hand (Favro 2006). This misleading and romanticised vision of the past, in analogue as well as in digital restorations, has been encouraged by cultural heritage professionals as it matches the

tendency of the public to see the past as a “golden age”, a perfect place to escape from a stressful and complicated reality (Urry and Larsen 2011, Walsh 1992).

In the Iseum79 model the spaces represented are those considered part of the archaeological Pompeian unit identified as VII.8.28, with the partial exclusion of the so-called Sacrum, as less archaeological evidence, fewer interpretations and fewer restoration hypotheses are available for it. In the other model (IseumGT) the only areas represented are those that were frequently reproduced and discussed in secondary eighteenth- and nineteenth-century sources. Therefore, for example, the so-called private rooms, that do not seem to have been visually recorded at the time of the excavations nor very often discussed in the written sources, have been excluded from this model. This choice is not only practically tied to the availability of visual records, but also consistent with the aim of visualising what was relevant in the eye of the early visitors, and what was their perception of the place. No human actors nor other contextualising elements have been added to either of the models, in order to stress the quality of synthetic architectural abstraction over that of “simulation of the past”. For the same reason, the single, neutral shade of grey has been used for all the untextured components of both models.

2.2.3. Selection of the sources and their role into the 3D modelling process

The models of the Iseum are built upon the information coming from several sources, different in provenance, media and context. The first step in collecting and selecting such sources, was a study and comparison of the Iseum’s blueprints. Due to the popularity of the Iseum and its early discovery, there are a number of architectural plans of the place, and, especially, of the main temple. I have selected, among those, three that seemed more appropriate because they were drawn in the first period after the Iseum was uncovered, their authors were established experts, and the drawings were quite renowned in the academic community. The accuracy and consistency of such documents has been checked against each other and against the material remains, that were measured in situ. The selected pieces of information have been integrated and used as a starting point to generate a new, digital plan of the Iseum complex, built ad hoc for the specific purpose of this proof of concept. The process will be discussed in more detail in the next chapter.

For the visualisation of the missing parts of the buildings, I have relied on material clues (such as the holes in the marble threshold of the temple to derive the shape of the entrance door), similarities with comparable features found in Pompeii or Herculaneum, documentation of the buildings at the time of the excavations, and most commonly accepted standards for Roman architecture in first century AD. With regard to the latter, the main reference has been Marcus Vitruvius Pollio's book *De Architectura* which is the most extensive, coherent and complete handbook on architecture surviving from Roman times. Although many archaeologists and architectural scholars have noticed that Vitruvian standards describe more an ideal-typical form of perfection than real life architectural practices (Ulrich 2007), it seems safe to assume that the rules described by Vitruvius are unlikely to be dramatically divergent from reality. Last, the Ten Books of Architecture were mandatory knowledge for architects and art historians in the past (McEwen 2003). As a consequence, many of the historical visualisations, hypothetical restoration and architectonic plans that I have consulted and used as secondary sources are explicitly or implicitly influenced by those books.

For the contextual information and the different interpretations of the place, old touristic guides have been a valuable source of information that allowed me to compare how the site was perceived by different categories of tourists and visitors 'from some of the greatest intellects of the twentieth century to the thousands of young soldiers passing through the Second World War' (Hales and Paul 2011:2), and how the interpretations have been changing through time. The guides show how different cultural institutions have sold and hyped Pompeian heritage, what aspects of it have been emphasised and what others have been consciously or unconsciously hidden in the building of narratives (Lazer 2009, Chard 1999). Before audiovisual mass media, touristic guides were the first contact tourists had with Pompeii before going there. Guidebooks and travel literature set up expectations about the visit and its priorities (Urry and Larsen 2011). Many of the printed guides were illustrated, offering not only verbal but also visual suggestions for the visitors' interpretations. Other cultural products meant for touristic consumption (such as postcards, souvenirs and old photographs) and for entertainment (such as novels, paintings, movies) have also been analysed and sometimes linked to the model. In addition to material produced for mass consumption, personal letters, diaries, travel journals, reports compiled by visitors of Pompeii and Herculaneum, from celebrities to common people over a span of 250 years, tell how well the idea of those ancient cities presented by literature

and advertisement was actually received, and if the real experience met visitors' expectations. Besides marketing strategies, this kind of secondary material reveals which attractions, and related narratives, actually struck the attention of the visitors and why.

2.3. The work of Gian Battista Piranesi as source and inspiration

The study and selection of the secondary visual sources depicting the Iseum has been one of the most interesting phases of this research, and will be separately discussed in relationship with their documentation in LOD (chapter five) and use as textures in the 3D model (chapter three). Among the secondary sources I have chosen, a special case should be made about the peculiar figure of Giovan Battista Piranesi. His drawings have proven invaluable during this work in two different regards: as accurate record of what was still standing on the site in the early years of the excavations (as his measurements proved to be the most reliable among his contemporaries), and as expert reconstruction about the original look of ancient buildings and decorations. The work of G.B. Piranesi, however, is not only a rich source of information, but it is also relevant from a theoretical point of view. The Italian artist, in fact, seems to be well aware of the interpretative components embedded in all visualisations of the past. From his writings, he also appears to be conscious of the political and critical weight of his images, and how that semantic charge could be used (and even manipulated) for communicative purposes.

G.B. Piranesi's drawings of the Iseum can be easily divided into two categories. Some of them look clean, with neat lines against an even background, frontal perspective, little shadowing. Good examples of this style are the drawings of the mosaics of the pronaos or those of the elevation of the main temple. The drawings that belong to the second category are larger views that include surrounding buildings and natural landscape, are much more shaded, display human and animal figures, and feature a number of entirely speculative elements. Although for my research I have relied almost entirely on the first category, G.B. Piranesi's fame is mostly due to the second ones, where, instead of following the Renaissance tradition of magnificent and balanced buildings, he represents them as ruins, in their decadence, frailty and materiality.

It is striking to look at the different outcomes produced by Piranesi around Pompeii. His more technical drawings are so accurate that often only insubstantial differences can be found

when checked against modern measurements. At the same time, in the more artistic landscapes and views, perspective is blatantly distorted, proportions sometimes ignored or played with. As his architectural drawings show his competence in both recording and representing buildings and spaces, we must conclude that his misuse of proportions and perspective is deliberate. This choice may suggest that what Piranesi is trying to achieve is not realism, but it is closer to how we today define a visualisation: a composition that rearranges historical information in a meaningful layout to communicate an idea of the past. Piranesi's stretched perspectives, the too large or too small human figures, give to the landscape an almost oneiric flavour. But, besides the speculation of art critics, the non-realistic intent of Piranesi becomes apparent when considering that he represents together monuments and buildings that never existed at the same time.

Piranesi was born in Veneto, and belonged to the group of artists sponsored by the Venetian Pope Clement XIII. It is easy to assume personal and stylistic relationships with the group of Venetian *vedutisti* that popularised the trend of the *Capricci*.¹⁰² Piranesi himself sometimes made a living selling *Capricci* to rich tourists in Rome.¹⁰³ However, the Venetian capricci painters usually had no interest in archaeological accuracy, but just wanted to create an atmosphere, to produce an effect of extravagance and charm. Piranesi, on the contrary, often represents actual ancient monuments, although in his own personal way. Using Stoppani's (2013) words, the Rome G.B. Piranesi shows in his drawings is a "palimpsest city", a multilayered entity in which the boundaries of time become softer. In other words, G.B. Piranesi found a way to show, before any digital technology was available, that past and present coexist in historical places; that their complex identities are made of both visible and invisible elements; that what is not visible anymore sometimes survives in public imagination, collective memory or even just fantasy, influencing the present and the future of that place. The Rome portrayed by G.B. Piranesi is a city that never existed in reality. But the monuments, the objects and the elements of landscape do live together in our imagination, in our memory and understanding of an ancient city. The ability to see together things that have existed in different times makes us able to perceive and investigate the evolution and change of a place, and its relationship with what was before and what will be in the future. Piranesi visualises not Rome as it is, but as we

¹⁰² Artists such as Ricci, Canaletto and Bellotto.

¹⁰³ Some of those drawings can be now seen in the Soane Museum, bought by Soane himself during his trips to Rome. Cf. Wilton-Ely 2013.

may experience and understand it¹⁰⁴. Piranesi's ambition to use visual means to represent what cannot be seen, makes him not only a source but also an inspiration for this research. Moreover, compared to the other artists that produced visual representations of the Iseum, he is certainly the one who devoted more time to codifying a documentation system, and experimented with the use of a visual language to switch from a linear narrative of history to a non-linear one: a process that mirrors quite closely the aims of this research.

2.4. From the choice of case study to the design of the ontology

2.4.1. The Resource Description Framework

According to the official W3 consortium webpage,¹⁰⁵ RDF was created¹⁰⁶ in order to be “a framework for representing information in the web”. In other words, it is presented as a means to attach metadata to web resources, in a way conceptually not too dissimilar from how metadata are related to objects and publications in the records of museums and libraries. In this sense, RDF appeared immediately not only as an adequate way to connect data and metadata to digital elements such as 3D files, but also as a means to establish and describe informative connections between those 3D files and other resources outside the 3D environment.

In addition, an RDF graph, i.e. a set of RDF triples,¹⁰⁷ is open-ended and allows different authors to add information (in the form of statements) about the same entities, without any of the authors owning (or controlling) the entire corpus of data. In this sense, the nature of RDF triples makes the stated information independent from the original entities themselves. It therefore enables multiple statements around the same entity, including inconsistent or even contradictory ones¹⁰⁸. In this sense, RDF technology has no means to prevent, for example, the existence in the graph of nonsensical, incorrect or deprecated information. But what the system gains in openness and variety seemed more valuable than what it potentially loses in

¹⁰⁴ Sigmund Freud was deeply impressed by Piranesi's art, and famously, he stated that Piranesi's views of Rome were the most effective metaphor of the human mind, with things that are visible and apparent being influenced by things that belong to the past and are now just ruins: completely destroyed or buried underground. See further Vidler 1992.

¹⁰⁵ <https://www.w3.org/TR/2004/REC-rdf-concepts-20040210/>

¹⁰⁶ Cf. also the entry for “Resource Description Framework” in wikipedia: “originally designed as a metadata data model. It has come to be used as a general method for conceptual description or modeling of information that is implemented in web resources [...]” Available at: https://en.wikipedia.org/wiki/Resource_Description_Framework

¹⁰⁷ Cf. RDF Semantics on the W3C website.

¹⁰⁸ Cf.: “RDF does not prevent anyone from making assertions that are nonsensical or inconsistent with other statements, or the world as people see it” in in Resource Description Framework (RDF): Concepts and Abstract Syntax.

consistency. Like all scholarly publications, 3D visualisations should aim at an accurate selection and analysis of the best and most reliable sources, unless the specific research questions demand otherwise. However, a multiplicity of information that is available in a LOD environment, all connected to the same material referent, including variant 3D visualisations and alternative sources, seems a more effective approach to the study of cultural heritage.

The presence of contradictory, controversial and/or erroneous information in a system that aims at documenting the representations and interpretations of cultural heritage can be seen as a better and more honest portrayal of the discourse around a complex object than one that is rigidly curated, closed and artificially consistent. As discussed in previous chapters, cultural heritage is rich and multi-layered in both its materiality and its interpretations. Under this perspective, the fact that RDF statements do not require the information about an object to be complete in order to be valid¹⁰⁹ seems, again, consistent with a framework describing and documenting something that is, by its very nature, never complete or definitive. Even deprecated and out-of-date information about cultural heritage is a valuable record, and it remains crucial, for example, to understanding the identity of an object, its reception, and the evolution of both its scholarly and the popular approaches. In other words, all information about cultural heritage sheds light not only on the interpretations of the object but also on the study of such interpretations. Moreover, according to their structure, RDF statements can only be linked by the relationship “and”. No other operator can be allowed, and all the statements are, therefore, on the same level. If this sound potentially confusing, it is also important to highlight that it is this lack of hierarchy that prevents any narrative in the interpretation of the cultural heritage object from emerging as dominant. This therefore allows, at least potentially, a diversity of voices to be represented.

RDF is an extremely flexible technology that, in its simplicity, enables statements to be made about any entity, thus ensuring that the method can be reasonably and successfully applied to a vast range of topics, whether Roman public architecture or any other kind of cultural heritage.

2.4.2. A domain ontology for documentation of 3D visualisation of cultural heritage

¹⁰⁹ Cf. “In general, it is not assumed that complete information about any resource is available”, in Resource Description Framework (RDF): Concepts and Abstract Syntax.

The application of RDF to model the information around a historical object or place appears to be even more successful when it is paired with the use of a domain ontology. There is no single accepted definition¹¹⁰ of what an ontology is or should be. In very general terms, it is a formal, explicit description of concepts in a domain of discourse. It is not the aim of this thesis to enter into such a debate, but, rather, to focus on what an ontology does, or can do, in a specific context, and to examine the qualities that would make it a suitable choice. Having in mind the purpose of a digital, accurate, collaborative and dynamic documentation of 3D visualisation of cultural heritage, the most useful function of an ontology is to make domain assumptions explicit (Ciula & Pasin, 2009). Having to state their choices and sources forces scholars into a more systematic reflection upon their own methodology. The latter, in fact, is a process so natural and so deeply embedded into a researcher's workflow that it becomes implicit and often invisible, even in the eyes of the authors themselves. Explaining every step of a methodology, trying to dissect the reasoning process, and declaring as many sources as possible sets a very high standard for documentation. However, one of the aims of SCOTCH is to change the way 3D visualisations are perceived and used, especially in academia, shifting the attention from an allegedly perfect and pristine final product to a process that is, intrinsically, always imperfect and incomplete. Moreover, once the process of creating scholarly 3D visualisations is formalised and expressed through a shared vocabulary (such as the SCOTCH ontology), the methodology becomes exposed. The documented 3D visualisation, therefore, holds huge educational value, as it shows, at the same time, information about the represented object and useful lessons on how to investigate, represent and communicate it.

As pointed out in the introduction, developing an ontology is a complex task that cannot be carried out by a single person. Nonetheless, this single-authored proof of concept has gathered enough data and methodological reflections to join the current debate on the documentation of 3D visualisation for cultural heritage.

SCOTCH is not meant to be a descriptive ontology. Its purpose is not to label the different 3D elements according to an architectural or archaeological taxonomy. There are already excellent examples of the latter that are currently used by the LOD community.¹¹¹ The main goal

¹¹⁰ For wikipedia, an ontology is "a formal naming and definition of the types, properties, and interrelationships of the entities that really or fundamentally exist for a particular domain of discourse."

¹¹¹ A very thorough job has been already done in this field by various institutions such as, for example, the Getty Foundation. Cf. the Getty Thesaurus of Art and Architecture at <http://www.getty.edu/research/tools/vocabularies/aat/>

of SCOTCH is to connect a 3D visualisation with its sources, and to formalise and communicate the process of investigation and representation of cultural heritage. The target users of this ontology, then, are scholars using 3D visualisations in their research, and students who want to learn about both the referent and the process of representation. It also targets those members of the public with an interest in the study of archaeology, history of art, or material culture and are willing to use 3D visualisations as means to explore and understand aspects of cultural heritage. Although this ontology potentially has other applications outside academia¹¹², this proof of concept focuses solely on the possible uses of SCOTCH in a scholarly context, as a means to enhance the value of 3D visualisations as research and teaching tools. Given its purpose, SCOTCH naturally revolves around the concepts of «representation» and «documentation». It pertains, mainly, to the sources that have been consulted during the development of the 3D visualisations, the research process that has informed the model, the other available representations of the same referent, and their relationships. More specifically, SCOTCH is meant to allow, as much as possible, not only statements about the sources behind a 3D visualisation, but also pointers to their digital facsimiles when available online, suggesting an almost straightforward comparison between the source document and the 3D representation, and supporting reflections on their relationship.

The SCOTCH ontology was initially drafted by hand, following what is, necessarily, an iterative process. During this process the ontology underwent various subsequent changes and refinements, as its structure was shaped by the actual data gathered for the case study, the specific needs of the documentation process, and the logical challenges that only become apparent when trying to formalise a domain of knowledge. For its intrinsically collaborative nature, the SCOTCH ontology is open to implementation, but all the main functionalities and principles are clearly designed.

Only when the general design of the ontology seemed more organic and coherent did I start using the dedicated ontology editor Protégé.¹¹³ The choice of Protégé was unproblematic. It seems to be widely used by the academic community, it offers solid documentation¹¹⁴ and it is easy to learn. It is also cross-platform, making it easier for any other collaborator to add to the

¹¹² As I have argued in Vitale 2016.

¹¹³ <http://protege.stanford.edu/>

¹¹⁴ <http://protegewiki.stanford.edu/wiki/ProtegeDesktopUserDocs>

work already developed, in order to expand and improve it. However, the use of Protégé is by no means a requirement to contribute to the documentation of a 3D visualisation. Protégé not only facilitated the delivery of a proper digital output in .owl format for my research, but proved to be a crucial tool during the entire development of SCOTCH. The software, in fact, ensures two different levels of control that help in identifying and preventing mistakes. First, an autocomplete function avoids the possibility of mistyping and establishing false connections. Second, a so-called “reasoner”¹¹⁵ performs a check of the consistency of the classes (as defined by the author), highlights errors and suggests solutions. Another useful feature offered by Protégé’s reasoner is the visualisation of inferred relationships. Using formal semantics enables both human readers and software to make inferences about the modelled relationship, making the amount of information actually available larger and richer than the amount of information initially put into the software. In order to exploit the effectiveness of the reasoner, I have defined the classes and properties of SCOTCH, and their relationships, as much as possible in formal logical terms. This process has made the ontology stronger and more coherent, clarifying the relationships between the elements that I was creating. Therefore, when describing SCOTCH in the following pages, I will give not only the definition of each different class and property, but will also mention their requirements and how they relate to each other (when relevant). Such a description is not only for the purpose of transparency, but is also crucial in understanding the function of each element in the ontological ecosystem.

The SCOTCH ontology will be described thoroughly in the following pages, but the actual file with the documentation of the 3D representation of the Iseum, in .owl format, is also part of this submission. The presence of this digital component allows additional queries on the data, in order to explore both the information recorded and the potential of the framework.

Unlike other documentation frameworks for 3D visualisations that aim at rating the sources according to their level of “certainty”, like the already discussed work by Blazeby (III. 62) and Johanson, SCOTCH is more oriented to connecting pieces of information than to assessing the alleged quality of the sources that have informed the modelling process. The statements in SCOTCH are mostly about the sources that have been consulted and their provenance. The purpose of such statements is not to evaluate the 3D representation nor the related sources, but simply to attest and record the sources on which the visualisation is based,

¹¹⁵ Specifically: HermiT 1.3.8.413

according to the author. As in any discipline, an author can, of course, lie about the sources they have consulted. Nonetheless, SCOTCH only records the statements of the author about the documents that have informed the 3D representations, and does not offer verification of such connections.

It is always difficult, when designing an ontology, to find the right balance between a very detailed model, rich in classes and subclasses but more difficult to use, and a more general model that of necessity loses something in the detail and precision of the representation, but becomes more approachable by different kinds of users (including non-specialists). The case of CIDOC CRM,¹¹⁶ the ontology designed to describe information about museum artefacts, which has rapidly grown to become a reference for a number of domain ontologies, is, in this sense, quite enlightening. An ontology that aims at modelling almost every entity in the realm of knowledge, from material to immaterial, and, moreover, to do so at a high level of detail, is a very ambitious piece of intellectual work. With its continuous contributions and expansions, CIDOC CRM is a rich and powerful tool. However, the very long list of categories and subcategories, and their complex properties, have proven in many cases discouraging for potential contributors of data (Sanders 2016). The initial investment to learn to use the ontology requires an amount of time and commitment that not all researchers or professionals in cultural institutions can, or want to, afford. With this precedent in mind, I have decided to lean towards usability and to create an ontology in which simplicity and clarity are prioritised above completeness and complexity. If needed, relationships can always be borrowed from other, more established ontologies, but SCOTCH's core, the link between 3D representations of cultural heritage and their sources, has intentionally been kept as simple as possible. One of the aims of SCOTCH, in fact, is to stimulate collaboration and engagement within the academic community, a goal that can be achieved more easily by proposing a system of documentation that is approachable by both expert and non-expert contributors.

2.5. Conclusions

This chapter summarises the peculiar history of Pompeii as an archaeological site, and how the many restrictions on its documentation imposed by the Royal Family during the first decades of the excavations impacted on the way the city and its buildings and artefacts were

¹¹⁶ Cf. <http://www.cidoc-crm.org/>

portrayed. Although Pompeii can be considered a peculiar example, many of the issues and the paradoxes related to representation that have been discussed here can be extended to all cultural heritage.

Among the secondary sources from the Eighteenth and Nineteenth centuries, I have singled out the work of Giovan Battista Piranesi. His drawings have been used in this work, and largely cited in this thesis, as a source of information for the 3D visualisation, as a reminder of the subjectivity of visual representation, but, also, as a methodological inspiration in the application of visual techniques to represent not the look of things “as they are,” but their informative value, showing connections that are more cognitive than material.

This chapter stresses how a LOD documentation of 3D visualisation can feature different sources, as well as different, but equally valid, hypotheses, thus producing a more complex and informative representations of cultural heritage. The non hierarchical structure of Linked Open Data allows different voices to be represented on the same level, and prevents one reading from becoming dominant. To widen the number of possible users, the SCOTCH ontology has been kept as simple and approachable as possible, in order to be more easily included into the modelling workflow and, in general, in the study of cultural heritage.

3. Modelling space and modelling knowledge about space

This chapter documents the workflows of the two modelling processes included this proof of concept, from their theoretical framework to the particular sources and data that have been selected and analysed. The first is the creation of the two CAD models of the Iseum in Pompeii, Iseum79 and IseumGT. The choice of tools and strategies will be discussed, in relation to their application in the 3D models. The second is the modelling of the SCOTCH ontology to document 3D visualisation. The ontology will be introduced in these pages through its premises, main goals and rationale. A fuller description of all its classes and properties will be given in the following chapter. As a necessary link between the three-dimensional representation of space and the discourse around it expressed in RDF, a convention to divide and name built space, either material or hypothetical, has been created ad hoc for this work, and will be presented and explained in this chapter.

3.1 Modelling the Iseum in 3D

3.1.1 Choice of CAD Software

The panorama of 3D modelling software is becoming increasingly rich and diverse, with more and more affordable products appearing on the market. For the visualisation of the Iseum, my choice has settled on 3DStudioMax¹¹⁷ by Autodesk for the following reasons:

Cost: a fully featured version of 3DSM is available for free on the Autodesk website for an unlimited time, for noncommercial use. The software is not only downloadable, but also upgradable for free, as long as the user can provide an academic credential at the moment of the update. The non-profit licence is not tied to a specific academic affiliation and does not expire with the end of such affiliation. It can be used indefinitely for educational purposes.¹¹⁸ All the other commercial CAD modelling software are available for a price, and, even with an educational discount, the cost made them immediately less appealing than 3DSM.¹¹⁹ Completely free, and quite popular options, such as *Blender* and *SketchUp Make*, have been discarded for other reasons not related to cost, discussed in the following section.

¹¹⁷ From now on 3DSM.

¹¹⁸ These were the the terms and conditions at the time I subscribed, in 2011. They have now changed in a less favourable way, following the shifting of Autodesk from traditional one off payment to the monthly subscription. The software is still available for free for educational purpose, but only for a limited time of three years.

¹¹⁹ Terms and conditions at the time I have started my research in 2013. At the moment, the educational offer of the two software, 3DSM and CINEMA4D is very similar.

Compatibility: 3DSM is the most commonly used software for 3D modelling in professional architectural design. Its native format .3ds is usually well supported by other 3D editing software and real time engines, such as, for example, *Unity 3D* or *Unreal*. Also, 3DSM shows very good performance in importing and editing non-native formats from other 3D imaging software, like, for example, *Photoscan* and *123D Catch*, for Photogrammetry, or *MeshLab* and *MeshMixer* for 3D editing. Besides its proprietary format, 3DSM exports in a variety of others, including the exchange format COLLADA (.dae), the open format .obj, and .fbx format. Although the latter was originally developed by Autodesk, all three of them may be imported and edited by almost all existing 3D software. In other words, in spite of being proprietary software, thanks to its popularity, 3DSM ensures a very high level of compatibility and successful interaction with any other 3D software relevant to this research, and with 2D image editors such as *Adobe Illustrator* and *Photoshop*. From this perspective, it also seems to be a reasonable choice in terms of longevity.

Features: unlike other less complex modelling software (such as *Sketchup Make*), 3DSM allows authors to manage the single 3D meshes more efficiently, and to modify each polygon of the mesh to the level of the single vertex. This was a crucial feature in this research, as I needed to attach specific information to each element, and to maintain the highest level of control on the model and its layers. 3DSM also ensures a good management of the textures and the different surfaces they can be applied to. Thanks to its direct interaction with *Adobe Photoshop*, every change made on the texture in the image editing software are automatically updated in the corresponding texture in the 3D model, considerably speeding up and facilitating the entire texturing workflow.

Time: looking at LOD and, in general, advocating open information as a premise for my research, open-source 3D modelling and image editing software would have been a more consistent choice in this context. Open-source options such as *Blender* for the CAD modelling, as well as *Gimp* and *InkScape* for the image editing, would have been the most likely solution. However, I have also considered time as a variable in my choice. Compared to 3DSM, *Blender* not only features a completely different set of tools and options, but is also developed according to a different logic and approach to geometries and volumes. I have been trained in CAD modelling with 3DSM, and the process of learning a new, and very unfamiliar, software package would have been too long and potentially confusing. As the format of the output will be .obj for

the model and .svg or .jpg for the images, I have concluded the question of with which software the data have been generated to be of secondary importance, as long as the produced output is in a shared, commonly readable format. 3D files produced in 3DSM and in *Blender* will be, in many respects, virtually indistinguishable from one another once published online in the same exchange format. The native .3ds file is also included as part of this thesis, for full transparency.

In the end, the very good balance between complex features and usability, the widespread compatibility with other software and the flexibility in importing and exporting various 3D formats, coupled with a time- and cost-effective approach, have definitely configured 3DSM as the best choice for the 3D modelling process.

3.1.2 Selection of the main sources of information for the 3D models of the Iseum

One of the most common, although often invisible, issues in visualisation of archaeological heritage is the number of diverse, and sometimes inconsistent, sources the researchers have to analyse and take into account. I have tried to address this topic in the documentation, and model it in LOD, also minting a few specific properties in the SCOTCH ontology. Nonetheless, I want here to give a brief account of the main sources I have relied on for the double visualisation of the Iseum, and describe the rationale behind my choices. This section focuses on the most relevant ones, and uses them as examples to show the workflow of the research process that precedes the modelling. A list of the documents that has been used as reference for this work, including historical images, textures, written accounts, is available as an annex of this theses. Even if not mentioned in this discussion or not used as specific reference for any 3D element, all the sources listed have been linked to the space of the Iseum via RDF triples.

Plans: I started studying and visualising the Pompeian Iseum—and, in particular the space commonly known as the Ekklesiasterion—in 2012, as part of my Masters dissertation in Digital Humanities. In that context, I produced a mass model (i.e. a non detailed model) of the main buildings of the Iseum, i.e. I only modelled the main volumes and geometries. The first step of the workflow was to find a reliable architectural plan of the area, as it was not possible at the time to produce first-hand measurements of all the remains in situ. Thanks to the popularity and early date of discovery of the Iseum, I found several records of the architectural complex. After a bibliographical survey, I focused on the three documents that seemed the most

promising candidates: the plans by Jean Claude Richard de Saint-Non (Ill. 47), Gian Battista and Francesco Piranesi (Ill. 49), and John Soane (Ill. 48). Other sources considered as possible choices were, for example, the drawing by Luigi Rossini in *Le Antichità di Pompei delineate sulle scoperte fatte sino a tutto l'anno MDCCCXXX* (1831), the drawing by De Jorio in *Guida di Pompeii* (1836) or the drawing by Mau in *Führer durch Pompeji* (1898). However, Saint-Non, Piranesi father and son, and Soane were considered more interesting choices due to the earlier dates of publication and the outstanding profile of the authors in the field of art and architecture.

The first is possibly the first plan of the Iseum ever published. It appeared on *Illustrations de Voyages pittoresques de Naples et de Sicile*¹²⁰, in 1781, when an official authorisation from the Neapolitan royal family was still needed in order to reproduce anything found in Herculaneum or Pompeii. As a consequence, a number of subsequent illustrations of Pompeian antiquities were more likely to be copies from Saint-Non (or the few other authorised authors) than original drawings. The very early date of its publication makes Saint-Non's plan a particularly valuable source, especially because of those architectural features that can no longer be observed and that are not recorded in later plans and documents. Elements such as the stairs in the so-called kitchen that suggest the existence of a second storey, are already almost disappeared in subsequent records, such as Piranesi's plan of 1804. Besides the added value of being such an early representation, Saint-Non's plan also seemed a reliable source because of the reputation of its author as an established draughtsman and engraver, specialised in antiquities. Although Saint-Non was himself an artist, he appears to be only the author of the verbal text of the *Voyages*. The 247 illustrations seem to have been drawn by different draughtsmen, including a certain Berthaut (no forename found) and the prolific J.L. Desprez. The drawings were also engraved by various other artists. I will refer to this plan as Saint-Non's since, in many cases, he is the only author named when this publication is mentioned. The second plan I examined was drawn by Gian Battista Piranesi and engraved by his son, Francesco, who had been involved with the family business from an early age. The father and son team authored the most detailed visual documentation of the buildings and decorations of the Iseum, published between 1804 and 1807, the *Antiquités de la Grande Grèce Aujourd'hui*. The final selected document was drawn by John Soane, one of the most influential Neo-classical British architects. He was also a known collector and *connoisseur* of ancient

¹²⁰ Saint-Non, Jean-Claude Richard de, (1781-86), *Voyages pittoresques de Naples et de Sicile*. Clousier (Paris).

artefacts, to the point that his own London house is now a museum displaying his remarkable personal collection of antiquities.¹²¹

In order to check the accuracy and consistency of the selected sources on their historical and architectural value, I have tried to superimpose them digitally, using transparency to overlay and compare the images. As often happens when dealing with historical documents, the three plans did not overlap perfectly. Piranesi and Soane's plans showed a certain consistency (Ill. 52), but it is also possible that Soane's drawings were actually a study of Piranesi's documentation and not a first hand record of the site. Saint-Non's map, on the other hand, seemed to be more substantially different from the other two (Ill. 53). Being unsure which source to use as main reference, I have looked for published measurements of at least one of the Iseum spaces to cross-reference the information. Eventually, I found hard measurements of the walls of the portico cited in a scholarly publication (De Caro 1992), and checked them against the plans. Piranesi's one proved to be remarkably close to the modern hard measurements, so I discarded Saint-Non's plan as less reliable. As I needed one main plan as a starting point for my modelling, I chose Piranesi's over Soane's plan, as the latter does not feature the entire architectural complex. Moreover, although geometrically consistent with Piranesi's plan, when checked against the scale at the bottom of the document, Soane's measurements proved to be dramatically wrong.¹²² The choice of a plan, to be later integrated with modern hard measurements, was crucial for the accuracy of the 3D visualisation I was developing. However, all documents mentioned, including those that have been discarded as sources of the 3D visualisation, are still linked to the conceptual space of the Iseum via LOD in the SCOTCH documentation framework.

As mentioned in the previous chapter, the work of Piranesi has been privileged over other options for several different reasons. In addition to those already discussed, another factor that can be added is the richness of the material produced by the artist. He and his son published not only a plan of the Iseum, but also an elevation (Ill num.) and two cross sections (Ill. num), plus a large number of more artistic and atmospheric renderings of the place. All the architectural drawings made by Piranesi father and son were published with a double scale in Roman Foot and Pied de Paris; a crucial feature in the perspective of unifying the spatial

¹²¹ Cf.: Wilton-Ely 2013.

¹²² There is no way to know how such a major error shows on the drawings of one of the best English architects.

information from the three different drawings. Moreover, a peculiar anecdote made the last work of the elder Piranesi, including the many studies of Pompeian buildings, especially rich in detailed annotations. According to Wilton-Ely (1978), Gian Battista did not have exceeding trust in his son's talents as a draughtsman and even less as an expert on Roman and Greek antiquities. Knowing that his health was deteriorating fast, Gian Battista took special care in commenting all his drawings for the benefit of his son Francesco, so that the work of the Piranesi brand (in which at least other two siblings were involved) could maintain the same level of quality in the eyes of the public. It is very hard to tell today if Gian Battista's worries were grounded or not, but surely the annotated visual records of Pompeii he left are today extremely useful. An example of the very long and verbose captions accompanying the material then published by Francesco can be seen in illustration number 35.

After selecting the scaled drawings by Piranesi that I was going to use as one of the main references for the visualisations of the Iseum, I proceeded to trace the plan, the front elevation and the double cross section (and the related scales) in Adobe Illustrator in order to obtain .svg files to be imported and compared in 3DSM. As reported in Vitale 2012, Piranesi's drawings showed a satisfactory compatibility when I converted the scale to metric units. Thanks to the richness of the recorded information, I was able to use one single author (although more than one document) consistently, both for the length of the elements (derived from the plan) and for some of the heights (derived from the elevation and cross sections). As the LOD documentation will show, in some cases I have used information derived from Piranesi's works as a surrogate of the measurements of elements that are still in situ but that I was not able to measure during my campaigns. In several other cases, Piranesi's hypothetical restoration of the Iseum served as a guide for the visualisation of how the Iseum might have looked like in year 79 AD.

When I was finally able to go to Pompeii and measure the buildings in the Iseum personally,¹²³ I could verify that Piranesi's plan and drawings were quite reliable on a general basis, but also showed some flaws, for example in the shape and measurements of the cella of the temple. For this reason, I have decided to take first-hand measurements of the whole complex and use them as a starting point to draw a new map, directly in 3DSM. Both the plans (the tracing of Piranesi's plan and the plan I have drawn according to my own measurements) are included in the model, as separate layers, but hidden in the renderings. The decision to rely

¹²³ In 2012 and 2014.

on a map based on my own measurements was only partly motivated by the wish to correct some inaccuracies in Piranesi's plan. A purpose-built, born digital blueprint has been considered an overall more transparent and flexible option than an historical source, as I could implement and adjust it with data gathered in subsequent campaigns in Pompeii.

Historical images

It is impossible to list all the depictions of the Temple of Isis that have been published and that are digitised and available online, especially considering the high level of redundancy and duplication in both their production at the time and the dissemination on the internet today. The SCOTCH documentation framework allows new resources to be added at any time, without compromising previous information, so completeness is not of paramount importance. In order to keep the documentation more manageable, and to make the discourse easier to follow, I have decided to focus on a selection of secondary sources. All the images that are part of such selection have been included in the LOD documentation (either as bibliographical citation or as URLs if a digital facsimile is available online), and a low-resolution copy has been added to this thesis as appendix (Appendix B).

The historical visual sources have been chosen according to a series of criteria. Documents that have been digitised and are publicly available on open repositories have been preferred, to show the full potential of a LOD based documentation. A certain variety has also been taken into account, to highlight differences in the visual representations of the same place, due to the change of cultural trends, graphic style, or printing techniques. The selection spans from dry and almost documentary representation of the excavation process, such as Fabris' *Lo scavo del Tempio di Iside* (Ill. 28) to heavily romanticised imaginative reconstructions of the place by Desprez (Ill. 3) or Leroux (Ill. 7). Considering a certain repetitiveness in the first illustrations, often presenting the same frontal view, any deviation from this standard has gained a place in the selection in order to improve diversity and to ensure a better documentation of the elements that are not included in the mainstream view, or that are usually not represented in great detail. Examples of these images are, for example two rear views of the main temple such as the one drawn by Gian Battista Piranesi (Ill. 36) and the one drawn by Elsen (Ill. 29)

Contemporary images and videos

One of the most interesting potential applications of this documentation is the opportunity to link social media users' travel pictures and use them as evidence or, in any case, as sources

or comparanda. Through linked open data, the documentation framework can exploit very large repositories of images such as Flickr or Picasa. Even without the explicit consent of the authors of the photographs, no copyright could possibly be infringed, as no download or modification will occur; RDF will simply point at something that has been independently published online. However this proof of concept does not need a large amount of photographic evidence from many different users to accomplish its purpose. A few examples will suffice to show the potential application. Therefore, the pictures used will be mostly my own,¹²⁴ to ensure the maximum level of control (i.e. that the photos will not be removed, or moved to another repository) and to avoid even the most unlikely objection from rightsholders. To show a little variety, I have decided also to include pictures that are published on the fairly established dedicated website PompeiiinPictures.¹²⁵ To complement more traditional photographic documentation, I have also produced a small number of videos, depicting the main areas of the Iseum. The videos have been uploaded to the same Flickr account, along with the pictures. The content of the video has been loosely indexed, and each video has been connected, via RDF, to the parts of the Iseum that it represents.

Historical textual documents

The choice of textual documents, such as letters, travelogues and touristic guides, has been mainly driven by their availability online, mostly in the very large repository at Archive.org. This obviously impacted on the nature of the examples that were analysed, and leads to a certain limitation and bias in the discourse. Almost all the written sources are in English and tend to perpetuate the same views of Pompeii. Some interesting divergences can be still observed, however, when comparing translations of French original publications. The different connotations of the Iseum, or one of its building, that emerge from such documents will be discussed in more detail in chapter five.

3.1.3 Measuring process

The measurements of the Iseum were taken during two different short campaigns: one in November 2012 and one in September 2014. The second campaign has been used partly to fill some informative gaps left from the previous one, and partly to retake measurements of the

¹²⁴ Available at: <https://www.flickr.com/photos/134064462@N06/albums>

¹²⁵ See further: <http://www.pompeiiinpictures.com/pompeiiinpictures/index.htm>

same elements and use them as a cross reference to random check the accuracy of the whole set of information. To undertake the measurements I have relied, to different extents, on four tools. The main one is an electronic distance measurer (EDM).¹²⁶ It is a quite simple tool that did not require any specific physical support or training. I have also used a regular soft tailor tape for the curved surfaces—such as column shafts—and a rigid tape for straight surfaces, especially those extending vertically. Finally, during the first campaign we were authorised to survey photographically the Iseum with a small drone. The drone is controllable via mobile device (iPad2), and streams what the camera is capturing on the display in real time, allowing a precise and tailored positioning, and the selection of the appropriate point of view. The equipment was not professional grade,¹²⁷ but nonetheless produced some useful footage and stills of areas of the complex that are not entirely, or easily, accessible to the researcher's eye. The multimedia material obtained (videos and stills) shows quite apparent limitations. Beyond the relatively low resolution of the output (compared to other imaging methods), it also displays a very clear distortion at the edges of the frame. The distortion being consistent, it could in fact be corrected with an algorithm, if necessary. So far, I have chosen not to do so, as I am using the recordings produced by the drone mainly as a source of insights for less visible details, rather as than material to produce textures or photogrammetric meshes. In order to optimise available time and resources, some of the smaller architectural features have not been thoroughly measured, but simply photographed next to the rigid tape, for reference.¹²⁸

The act of measuring is only apparently simple and straightforward. As Hodder and Hutson (2003) remark:

(a)[...]what one measures depends on perception and categorization, and (b) [...] there can be no independent instruments of measurement since methodology is itself theory dependent. (2003:18)

In the first place, it is not possible to measure everything. Not only because in every campaign there is only a limited amount of time, but mostly because of the nature of the

¹²⁶ Bosh DLR130.

¹²⁷ Parrot AR drone.

¹²⁸ Cf., for example, <https://www.flickr.com/photos/134064462@N06/19720427606>

process itself. Complex objects like an ancient building could theoretically be endlessly divided into smaller parts, in order to have more detailed information. Not just length, height and depth, but curvature, inclination, sloping, changing in materials, and presence of decoration could be considered measurable variables. It being simply impossible to record all the information of a material object in the real world, I had to make a number of choices about what to measure and what to ignore, bearing in mind the purpose of my proof of concept. Therefore, considering that I did not intend to model all the decorative details (such as the precise shape of the wall niches, the intricate lines of the Corinthian capitals or the stucco remains), I thought it was not necessary to measure those features accurately, and focused instead on the main volumes and their spatial relationship. Another criterion for selecting the elements to measure in situ, was the necessity to fill the informative gaps first. Once it was verified (through randomised cross references) that Piranesi's drawings were, overall, reliable enough, I gave priority to the information that had not been recorded on those documents, such as, for example, the position and dimensions of the niches in the portico walls. Then, I proceeded with measuring all the main architectural components.

Most of the spatial information that is shared between the two models of the Iseum is based on my own measurements. However, if during the 3D modelling process I realised that some bits of information were missing, I have used Piranesi's plan and cross sections to derive them. As the main reference was still the plan I drew in 3DSM from my measurements, the information derived from Piranesi is, in any case, adapted and positioned according to the new layout. For example, the height of the Doric capitals of the columns in the portico is derived from Piranesi's drawing. Nonetheless, the 3D model of the capital (as well as the entire column) is positioned in the virtual environment according to my measurements, and not Piranesi's plan. The approach may sound inconsistent, but, as I am about to argue in this chapter, it reflects the complex panorama of sources consulted by 3D authors during their research. The focus of the SCOTCH documentation framework for 3D visualisation is to make the provenance of the different bits of information always traceable, regardless of their quality or consistency.

The EDM needs to be projected on a surface in order to work. This characteristic of the tool highlighted one practical and one methodological issue. The practical one concerns recording the heights of those elements that could not be measured with the rigid tape, and did not have a protruding element the laser light could target. In those cases, I have used the

triangulation method and simple geometric rules, the Pythagorean theorem, to calculate the height of the element, considering it one of the sides of a right triangle of which I knew the hypotenuse and the other side. The methodological issue concerns the unevenness of surfaces in ancient buildings. I have encountered this problem several times when measuring Pompeian walls. On the walls of the buildings of the Iseum, for example, the plaster layer is often still visible, sometimes as small fragments, sometimes covering almost the entire wall. The value given by the laser measurer for the length of a wall would change if pointed at the surviving plaster or at the bare wall. Not only had I to decide at which surface to point the tool, but also to deal with the fact that not all the walls had fragments of plaster in a suitable position to be measured, and not all the walls had a bare section exposed. It was not possible, therefore, to choose a single criterion and be consistent. When possible, I have targeted the light at the level of the plaster, as one of my aims is to give an impression of how the place might have looked to the eyes of a past visitor. The layers of plaster being about 4-5 cm thick, this inconsistency has embedded a basic level of error in my model. Such error, however, has been considered negligible, given the scale of the representation. Likewise, an embedded error results from the unevenness of the ground. It is very unlikely that the current level and shape of the ground is the same as it was at the time of the eruption or at the time of the excavations. In some spaces, such as the Temple's cella or the Ekklesiasterion, remains of the floor mosaic give at least an idea of the original ground level. However, such information is not available for all spaces and, even when it is, it could not be accurately recorded with the available equipment. The ground level of the whole Iseum complex is artificially considered flat and consistent. The fact that the unevenness of the ground has certainly affected the measurements of heights (as the EDM had to be positioned on the ground in order to record, for example, the height of doors and arches) is ignored for the sake of simplicity. A sample of the measurements I took on site, can be found in Appendix C (Ill. 69, Ill. 70).

3.1.4. Creation of the digital textures for the IseumGT model

The images that have been used in this proof of concept both as digital textures for the surfaces, and as sources of information for the appearance of the Iseum, are heterogeneous in many respects. For several of the modelled spaces, more than one resource was available. Developing only one variant for each of the textured surfaces, I have assessed which was the

best option for each of them. Here I will discuss the criteria of my choices on a case by case basis.

On the one hand, it would have been more consistent to use the same author, or at least the same main resource, as reference for the textures of all the areas of the IseumGT model. Such a choice would have ensured a higher level of homogeneity in the visualisation, and more consistency in the calculation of scale, and other architectural conventions. However, two main issues persuaded me to follow another path. The first is practical and cannot be ignored or worked around: there is no single source, among those I am aware of, that reproduces all the relevant surfaces of the Iseum. None of the publications examined, not even the prolific Piranesi or the team of artists hired by the royal family in Naples at the time of the excavations, record all the spaces, internally and externally. This matter of fact goes beyond any scholarly argument on the choice of the sources, making it simply impossible to rely on one single provenance for all the pieces of information. However, even if in a hypothetical scenario such a resource were actually available, I would have avoided using it nonetheless. If it is true that it would have enhanced the consistency of the data, it is also true that it would have turned the IseumGT visualisation from a representation of the Iseum as it was at the time of the Grand Tour into a representation of the Iseum as it was at the time and in the view of one specific author. My objection is not meant to suggest that my visualisation of the Iseum in its early years after the discovery is to be considered an objective representation, but that the final image is a grounded and documented negotiation between views of different authors and, thus, closer to reality in the sense that it is multivocal and possibly slightly inconsistent, exactly as reality is, in the eyes of different witness.

As many scholars, such as Elia (1941) and Sampaolo (1992), point out, the information about the colour of the artefacts in the early printed illustrations sometimes appears to be dramatically incorrect. Surprisingly, the verbal accounts have proven to be overall more reliable on this matter. Although it would be interesting to investigate further the reasons for this phenomenon (from limitations due to the printing techniques of the time to, perhaps, personal preferences), this observation is a useful reminder of how problematic it would be to use historical visual records as a guideline to restore colour in a digital visualisation. The illustrations recording the frescoes of the ekklesiasterion (Ill. 40) displayed in the museum of Naples are a quite striking example, they being exhibited in the the same place where visitors can actually

see the original fragments and compare the two images. But there are more examples that show how the issue with colours seems to be ubiquitous. For example, in the statue of the Venus Anadiomene found in the temple, formerly located in the west side of the portico, the robe covering the hips and legs of the goddess, assimilated to Isis in Roman mythology, is depicted in an earthy red by Niccolini in *Le Case e i Monumenti* (Ill. 41). However, in the written reports, the same robe is recorded as blue. This choice would be more consistent with the colour traditionally associated with Isis in the Roman world (Witt 1997). It is probably revealing that, in the illustrations by Niccolini, there is no trace of any blue element. A notable exception in this sense is the small building of the Purgatorium, that seems to be consistently depicted in bright green and yellow in most of the colour illustrations (for example Ill 31, Ill 28). As my visualisation focuses more on the architecture of the Iseum than its decoration, I have decided to ignore information about colour and use only black and white illustrations for all areas of the Iseum. Even if discarded as textures, the documents showing colour information have been linked to the 3D visualisation via LOD.

All the visual records of the Iseum that I have analysed are two-dimensional visualisations of three-dimensional objects. This fact, coupled with a certain repetition in the choice of angle represented, has excluded some of the surfaces from all the drawings and paintings. This is the case, for example, for the depth of engaged columns or decorative mouldings that have projections. For instance, only the very front surfaces of the twin niches at the sides of the main temple could be textured.¹²⁹ On the other hand, some of the illustrations recorded details of volumes that, for simplicity, have been excluded from the geometrical modelling. An example can be seen in the rendering of the East wall of the portico, where the decorative features that frame the niche in the wall are depicted in the texture, but they have no three-dimensional referent in the model.¹³⁰

Most of the drawings, especially those executed by the artists of the Neapolitan Academy of Arts, have proven to be remarkably accurate in their measurements. Therefore, it has required very little editing to create textures from them, even in the case of more complex surfaces, such as the arched wall on the west side of the portico. Nonetheless, some transformation and deformation were necessarily undertaken. For this reason the SCOTCH

¹²⁹ See rendering of the elements called in the SpC_F0_GT 1 and SpC_F02_GT in Appendix E.

¹³⁰ See rendering of the element called SpA_CoE_GT in Appendix E.

framework considers the texture and the original image it is derived from as two separate entities, with different authors. Both entities are linked to the digital 3D element via RDF. The documentation of textures will be discussed more thoroughly, with the other specifications of the ontology, in the subsequent chapter. When no textures could be created from the available documents, surfaces have been left in the same neutral grey colour of the Iseum79 model. When parts of the image had been removed in order to create a texture, the cuts have been flagged with the use of the white colour, as can be seen in the renderings of the floor of the main temple.¹³¹

Portico: the most exhaustive source for this area of the Iseum is, undoubtedly, the detailed record produced before the frescoes were removed and transported to the museum in Portici. The authors of the illustrations are a pair of artists from the Neapolitan Accademia delle Belle Arti: Giovanni Casanova, as draughtsman, and Aniello Cataneo as engraver. This series of illustrations is an invaluable resource in the study of the original appearance of the Iseum in Pompeii. It is also the main reference on which the documentation of the fragments of frescoes exhibited in the Museo Archeologico di Napoli is based. Their informative value has been entirely recognised by the curators of the Museum in Naples, and both the illustrations and the original plates are themselves displayed in the thematic rooms dedicated to the Iseum.¹³² A schematic reproduction of the illustrations is printed on metal supports in the exhibition area, as a guideline for the viewers to understand the original position of the fragments of frescoes, helping the public to establish, at least in their imagination, those relationships and connections that the museum cannot materially display due to the lack of space.

The files used in this 3D visualisation to texture the walls of the portico come from digital scanning of two different printed resources, and therefore show different graphic qualities. I have decided not to edit the images to make them look more homogeneous in terms of light and contrast. On the contrary, I wanted the diversity of sources to be clearly identifiable not only in the documentation but also visually. The longest walls of the portico, the North and South, have been recorded not as a single images, but each in three separate panels. In the case of the North wall, the three panels can be quite easily merged to simulate their continuity. For the

¹³¹ See rendering of the element called SpC_CoD_GT in Appendix E.

¹³² See also: Sampaolo 1992.

South wall, unfortunately, the central panel appears to be missing.¹³³ Therefore, the wall appears partly untextured on the IseumGT model.

Ekklesiasterion: the secondary sources for this space are rather analogous, in provenance and style, to those for the portico. They are also part of the official documentation produced at the time of the excavations, before the detachment of the frescoes. The draughtsmen are Giuseppe Chiantarelli and Giovanni Casanova, and the etcher is Giovanni Morghen. In this case too, the files are the digitisation of two different printed publications. Information about the East wall of the Ekklesiasterion appears to be missing, so the related surface has been left untextured. It would be possible, theoretically, to use photographic documentation of the surviving fragment of frescoes to texture some of the surfaces that did not seem to have found representation in historical sources. However, the aim of the IseumGT visualisation is not to fill as many gaps as possible, but to highlight which were the features that most caught the attention of scholars and tourists at the time. Although this is surely a simplification of the issue, only images that were part of publications during the years of the Grand Tour have been considered as possible textures. Of course, all other images, including those of the fragments of frescoes, have been linked to the representation of the Iseum via SCOTCH.

The illustrations depicting the portico and the ekklesiasterion look quite homogeneous in style. The observation is not surprising as Giovanni Casanova was involved in both works, and, in general, the whole group of artists received the same training in the Neapolitan Accademia delle Belle Arti (Harris 2007). This similarity gives the textures a certain continuity, without compromising the idea of variety that I wanted to stress. The scales that accompany each of the illustrations for the portico and the ekklesiasterion give good clues to the height of the supporting wall at the moment of the excavations, and is a crucial help in reconstructing the exact position of each fragment. However, as D'Alconzo 2002 explains, it is important to remember that, looking at the techniques used at the time to remove the frescoes from the walls, it appears that the plaster was cut leaving a border on both the lateral edges. Traces of painted plaster can still be seen in the corners of many Pompeian buildings where the frescoes were removed, including the portico of the Iseum itself. It is reasonable to assume that a bottom

¹³³ According to Sampaolo 1992, the missing original copper block has been recently found in the archives. However, it has not been published yet. The open ended nature of this model allows that, if further sources will be identified in the future, the missing texture could always be added.

border was also left in place at the moment of the extraction, and not included in the documentation. The geometry and proportions of the walls drawn in the official Eighteenth-century documentation, in fact, seems very similar to that of the actual walls, although smaller. This led me to think that the cuts were carried out leaving a roughly similar amount of plaster on the wall, not only on the sides but also on the bottom and top.¹³⁴ In addition, keeping in mind that these frescoes were detached during the early years of the excavations, it is likely that the floor was covered in rubble and debris, making it very unpractical to work on the very bottom line. Although there is no way to prove this theory, another clue can be found in the analysis of the subject of the frescoes (Vitale 2012). The frescoes on the walls of the ekklesiasterion are examples of Pompeian fourth style, and reproduce illusory, complex architectural features. Comparing the records of these frescoes with those that are still in situ in Pompeii, and, in general, with other similar decorations in Roman houses, it seems that the illustrations we are observing miss something in the bottom part, as the tridimensional illusion seems somehow incomplete and less effective than other similar examples.

In these respects, using the images of the portico and ekklesiasterion to texture the entire surface of the corresponding element in the IseumGT model, certainly feels like a simplification. However, it was considered still appropriate in the context of a proof of concept that focuses more on representing and documenting the provenance of the sources than on the archaeological value of the model.

Pronaos: two different sources have been used as textures for this area. The first is the record of the now disappeared floor mosaic drawn by Francisco La Vega, (III. 22) director of the excavations from 1780 to 1797, who personally contributed to the detailed documentation of the Iseum. The second is the elevation of the temple drawn by Gian Battista Piranesi (III 8.), featuring the decorative stucco adorning the facade of the main temple. Although a version of the elevation could be found in La Vega's documentation as well, Piranesi's has been preferred because of its slightly cleaner graphic style that makes it easier to use small portions of it as textures. Both images realistically depict the elements that are still in situ. Therefore some elements appear to be hidden by shadows, making it not always possible to create textures. The stucco cornice of the podium of the main temple is an example of very dark and low

¹³⁴ See further: Vitale 2012

resolution textures that could be derived from realistic impressions of the main temple.¹³⁵ Some editing was necessary in the textures of the stucco decoration of the pronaos, to remove the shadows that, in the drawing, are projected by other elements. I have used the same image, mirrored, to texture the two sides of the main temple, which were symmetrical. The operation will be transparent in the SCOTCH documentation as both surfaces will point at the same file as textures, and at the same original image for comparison.

Although the accuracy of the early documentation of the Iseum is generally high, not all documents achieve (and maybe were not meant to achieve) the level of geometric precision that a CAD software grants (and imposes). As shown by the illustrations number 71 and 72 in Appnedix C, La Vega's drawing of the mosaic floor are consistent with the measured layout of the temple of Isis, but not enough to be used in a large texture. Smaller parts of the drawing of the floor were then selected and placed according to the new plan of the temple. As already stated, the colour white is used to flag that cuts were made on the original image.

No suitable records of the interiors of the temple have been found. It would have not been challenging to texture those surfaces producing a graphic version of the original simple marble decoration, based on what has survived. However, the aim of this visualisation is to show what the early researchers and artists were focussing on, more than producing brand new, even if more accurate or informative, visual material about the Iseum. For this reason, the all the internal walls and features of the temple have been left untextured.

In the case of the Purgatorium, similarly, no records seem to be available of the interiors of the small building nor of its underground area. The exterior walls, on the contrary, have been depicted several times, although often in more artistic outputs that proved to be unsuitable for the purpose of texturing. For the Purgatorium's façade the very clean records (Ill. 9) that A. Mau published to illustrate his study of Pompeii in 1882 has been selected as source for the textures. The German scholar only recorded the left half of the facade. The texture has been developed assuming that the decorations were entirely symmetrical (which would also explain why Mau only drew half of them). The drawing has been copied and mirrored to texture the right half of the Purgatorium entrance wall. For the side walls (east and west), I have created a texture from the detailed impression drawn by La Vega. Another available option was again to use Mau's drawings. However, in his illustrations, Mau had focused only on the main

¹³⁵ Cf. the rendering of SpaceC_GT in Appendix E.

mythological scenes represented in the bas reliefs, completely detached from the architectural components and other decorative elements (such as the small architrave), and with no information about scale or relative position. Although it would be relatively easy to place confidently Mau's drawings in their right places on the model, as the traces of the bas reliefs are still clearly visible today, La Vega's works have been considered a more satisfactory choice because of its completeness.

Sacrarium: in spite of being still covered in frescoes when it was excavated, the space known as Sacrarium only has one record from the time of the excavations, i.e. the official one executed by La Vega. After the frescoes were transported to the museum of Portici, the place received even less attention from tourists and it is systematically ignored in visual and textual accounts even of the early years. I thought of completely excluding this area from both the Iseum visualisations, on the ground that it had little relevance in the eyes of the public of the time (and, in fact, in the contemporary view as well). However, documentation of the sacrarium is available and seems quite detailed, and it would be interesting to make it more acknowledged among the public. For the other areas that seem neglected by the attention of early visitors, such as the private rooms, no visual documentation seems to be available (although these rooms did feature some frescoes that are now on display in the museum). Thus the decision to leave them out of the model seemed the most appropriate.

Looking at the selection that both managers of the site and visitors seem to have made, it should be pointed out that a similar issue may trouble future researchers when looking at today's evidence. A brief exploration of the available pictures would show an overwhelming number of images of the exterior of the temple and the Purgatorium, but, basically, none of the interiors. Today, the reason can be found in the inaccessibility of those areas without a special permit issued by the Soprintendenza degli Scavi. Thus, the lack of photographic evidence from regular tourists or amateurs appears quite explicable today. However, there does not seem to have been a similar restriction at the time of the excavation. Old photographic evidence suggests complete access to all areas of the Iseum.¹³⁶ I am not able to suggest a reason for the missing documentation of some of the spaces of the Iseum, the possibilities spanning from a lack of interest to practical or legal issues we are not aware of.

¹³⁶ Souvenir pictures of travellers posing on the stairs of the temple, or even in its inside appear to be not uncommon until few decades ago.

3.2. Modelling the knowledge about space

3.2.1. A dividing and naming convention for built space

A crucial step in the creation of the proof of concept was to establish a naming convention for the spatial elements. The system had to meet some requirements in order to be effectively used in this context. First, it had to be consistent with both the linked data and 3D modelling logic. It also had to be easy to understand and remember, so to facilitate collaboration between different researchers.

The study of Roman architecture relies on a quite formalised vocabulary and there are several thesauri available online.¹³⁷ Using conventional human readable labels to identify the different areas would have had the advantage to make the elements easier to access in the model, both during the developing of the prototype, and by potential current or future collaborators. However, the existing vocabularies for cultural heritage (and in particular Roman architecture) tend to be descriptive, i.e. to assign labels to architectural components that often carry a strong semantic value such as “triclinium” or “frigidarium”. The use of very standardised labels often implies assumptions about the use of the elements, and leave little room to variant interpretations. The use of conventional architectural names may seem unproblematic, and actually useful, in the analysis and representation of a sacred space such as the Iseum. Although this research is limited to a proof of concept that only involves one example, it theoretically aims at finding a method that can be reasonably applied to different buildings in Pompeii and different kind of built cultural heritage. If temples, and to a certain extent monumental buildings, are quite consistent and predictable in their layout, other spaces are more ambiguous, and their interpretation controversial.

Although it is not possible to think of a naming convention that has no interpretative implications at all, I have chosen to use the letters of the English alphabet to label the different components of the model. The order in which they are applied is random and bears no additional meaning, i.e. it doesn't express any relationships such as dependency or contiguity. This choice highlights how this documentation model allows any arbitrary labels used, as long

¹³⁷ The most popular example is the Getty Architectural vocabulary, but the naming convention in this field is fairly crystallised since centuries before the advent of digital ontologies.

as the use remains then consistent within the community of users. Once identified with a neutral label, one or more interpretations about name and use of the elements can be assigned via RDF triples. For example, an element “A” is (potentially) type «kitchen» according to one scholar and type «storeroom» according to a second.

In the case of the Iseum, the identification of the main components does not seem to be particularly controversial. The different architectural blocks stand out rather clearly, and, before making (or agreeing on) assumptions on the use of the spaces, they appear to be quite unproblematically separated from a geometric and structural point of view. To illustrate how I have divided the space of the Iseum, I have used Saint Non’s plan of the Iseum complex showing how my labels have been assigned. The table can be seen in Appendix D. To facilitate the reading of this thesis, I will define spatial elements through both the letter assigned in the documentation and the most commonly used name. This use of labels such as “main temple” or “ekklesiasterion” is only intended as a facilitation to improve the readability of the present document. There will not be any univocal relationships between elements and word labels either in the 3D model or the RDF triples.

Once it was decided to use neutral names, the next step was to decide how to group or break down the components of the model (or rather of the material referent). In other words, I had to identify what were the minimal units to deal with in the proof of concept, the entities that would receive a URI. The first issue related to this choice was to identify the appropriate level of granularity. It soon became clear that an ontology aiming at being a standard for a large community could not impose a single level of granularity. A project dealing with procedural modelling of an entire city and a reconstruction of a single room or artefact cannot be expected to work with the same categories. The categories, then, needed to be generic enough, so that the system could adapt to different projects.

After testing some of the existing space denomination standards, such as IndoorGML, I discovered that none of the available choices seemed simple and flexible enough to be used for the purpose of dividing and naming ancient places. A convention to divide and classify space was nonetheless necessary to develop a prototype. Therefore I decided to experiment with a simple one developed ad hoc for this project and called SCaT (Spaces Constraints and Transitions). However, it should be noticed that, the methodological structure of the SCOTCH

documentation framework is independent from the spatial standard that is applied, as long as the community agrees on the choice.

3.2.2. Spaces Constraints and Transitions: introducing the SCaT naming convention

Therefore, The word I have chosen to designate the minimum unit of the model is “element”. It seemed abstract and general enough to cover both the tangible and intangible domains. There are no limits to the number of elements or to their size in any 3D visualisation, as both these parameters depend from the granularity of the particular research. Theoretically, the same model could be further divided by another author, or by the same author at a different time, creating new entities within the ontology and assigning them new URIs. Elements can be broken into sub-elements or grouped in super-elements, and all the spatial relationships are declared in the LOD documentation. Looking at the plan of the Iseum, for example, it is quite apparent that the temple can be divided into Pronaos and Cella. The division into sub-elements may also develop along a vertical axis. The Purgatorium has a ground level room, as well as an underground one.

The classification of spatial elements I propose, is built on only four categories: Spaces, Constraints, Transitions and Features. They have been used to generate a consistent naming convention to refer to the elements in the virtual environment. Probably, these four terms, combined with orientation, would be sufficient to label all the elements in the Iseum. However, I have also included some further specifications, that might prove their usefulness in the future, in possible research contexts that go beyond this proof of concept.

As “spaces” are labelled those elements that allow human activities to happen within them. Straightforward examples of spaces are all sorts of rooms, but also gardens, porticos, and courtyards. “Constraints”, on the other hand, are elements in which activities cannot take place, and usually serve as boundaries for spaces. The most common type of constraints are walls, but colonnades, podia and roofs are also considered constraints within this convention. A space should be delimited on each of its sides, including not only the four cardinal orientations but also up and down. In ScaT the constraints will be indicated with the following abbreviations:

N: North

E: East

S: South

W: West

D: Down

U: Up

For example, the wall where the main entrance of the Iseum is located will be called the North constraint of Space A (portico).

An overview of Roman architecture shows that not all the constraints are tangible. A change in the mosaic pattern, as often visible at the entrance of a tablinum, can delimit a space, even if there are no walls to mark the separation. More precisely, tangible constraints can be divided into permeable and impermeable. To the latter clearly belong plain walls or gates. To the former, belong, for example, colonnades or fences. Although some constraints (such as colonnades) are physically permeable, it is likely that they were not always considered as such in practice. It is hard to imagine, for example, people passing through the pronaos colonnade in the Temple of Isis, or worshippers stepping behind the altar in a Christian church. Likewise, although all intangible constraints are, for their own nature, permeable, some of them were probably made non-permeable by social conventions. As it is impossible to establish what the practice was in Roman times, and because the convention itself probably did not apply to all agents in the same way, I have decided to consider only the material qualities to assign a constraint to one or the other category. Likewise, archaeology shows evidence for temporary constraints, such as removable blocks, wooden fences or curtains. The existence of temporary constraints implies the possibility of temporary spaces, i.e. of spaces that were transformed on particular occasions. Although interesting from a theoretical point of view, such condition has not been considered in this particular proof of concept and I have decided to deal exclusively with permanent constraints.

“Transitions” are those elements that connect spaces and, as such, they do not belong to either of the two elements they join, but are independent. Although there are elements that can have a transitional function, such as an antechamber, for example, I have considered transitions only those elements whose only possible purpose is to connect two (or more) other elements and could not be repurposed in any other way. The most common example of transitions in this

work are doorways and stairs. Theoretically, SCaT differentiates between two kinds of transitions: the ones that allow physical access from one place to the other (such as thresholds or stairs) and the ones that allow visual and/or aural access from one place to the other (such as windows). In this proof of concept, however, only the first case will be considered.

All spaces, constraints and transitions can have “features”. The word is used here to indicate “a distinctive attribute or aspect of something”.¹³⁸ Features often pertain to the decoration of a space, or a constraint, or a transition. In general, it is easy to identify features of constraints, as they are contiguous to them. For example niches in the walls, engaged columns, mosaic floors. The features of transitions are also relatively easy to identify, such as, for example, window moulding, or doors. Stand-alone features, that have no physical contiguity with any other element (such as altars or statues), are considered features of the space in which they are situated. For example, the altars on the side of the main temple (Space C) of the Iseum are treated as a features of space A (Portico).

The same constraint can delimit more than one space, especially when they are sub-elements of the same space. For example, the roof of the temple (Space C) delimits both the pronaos (space H) and the cella (Space I). Instead of creating artificial divisions, in those cases the constraint is considered as belonging to the superspace that the two contiguous spaces share. In the example of the roof, it will be identified as the Up constraint of Space C (main temple). Neither Space H nor Space I will have an upper constraint listed in the documentation, as they will both considered under the Up constraint of the common super-space C (main temple).

One limitation that I have encountered with existing space analysis standards, such as the Indoor GML, is that walls, and other constraints-like elements, are considered as single entities. However, looking at the 3D models of the Iseum, it can be noted that a wall such as the one between the South side of the portico and the complex of the so-called Private Rooms (SpaceG) is linked, in a different way, to both spaces. Therefore, the side of the wall that is involved in the delimitation of the portico (SpaceA) is ontologically different from the side of the same wall that delimits the private rooms (SpaceG). In these cases, the way in which architectural elements are built in this 3D model provides a useful way to disambiguate. In this proof of concept, all the constraints are not built as solids, but as joint surfaces. For example,

¹³⁸ According to the google dictionary definition.

walls are represented through two parallel surfaces, created and managed as separated objects. Returning to the previous example, it will not be the entire wall that is associated with one space or another, but the individual surfaces: one will be the South constraint of Space E (ekklesiasterion) and the other the North constraint of Space F (sacrarium). As a consequence, they can be independently textured with different images,¹³⁹ and connected more precisely with the related documents.

Although it would be interesting to use 3D environments to test what areas of the sacred space were accessible to different groups, according to their status and privileges, in both my models I have chosen to disregard this issue and simply visualise all the elements visible to an hypothetical human observer with full access to the whole Iseum. This approach excludes from the visualisation all those architectural elements, such as roof structures, that are crucial to the very existence of the building but that are, nonetheless, structurally hidden from view. The first reason for this choice is to keep the model at a level of detail that is manageable in the time-frame of this doctoral research. A second reason is more methodological: the purpose of this representation is not to test, or show the material structure of the building, but to reflect on how the Iseum was seen and perceived in different times and according to different narratives, and to create a formal documentation of the sources that have informed the model. Therefore, the inclusion of invisible elements would be scarcely relevant to this project.

Once a naming convention was established, the second step was to assign URIs to the Iseum, and subsequently to its parts, in order to link the different resources and the variant visualisations via RDF. I have looked into Pleiades, the most widely used online gazetteer for ancient places, for precedents of URIs assigned to ancient buildings. At the beginning of my research, Pleiades addressed mostly units of space that were on the scale of settlements or geographic features, such as rivers or capes. A notable exception was the ancient settlement of Aphrodisias in Turkey, where a few of the major buildings had been identified and being assigned a URI, following the needs of the digital project on the Inscriptions of Aphrodisias.¹⁴⁰ Some of the major Pompeian monuments, like the Amphitheatre or the House of Dionysus, were also among the few exceptions. In the past three years, the need to assign specific URIs to ancient monuments has emerged quite clearly in the community of digital classicists and

¹³⁹ It is very likely that the two sides of the same constrain, most often a wall, will look very different on the two sides. The sophisticated decoration of the ekklesiasterion is bound to be very different from the one of the sacrarium.

¹⁴⁰ *Inscriptions of Aphrodisias* (Reynolds et al. 2007), <http://insaph.kcl.ac.uk/>

historians, and has been addressed by projects such as the Heritage Gazetteer of Cyprus¹⁴¹, iSicily¹⁴² or the Heritage Gazetteer of Libya.¹⁴³ Pleiades itself has started improving the granularity of its mapping. To create a LOD environment where a URI for the Iseum was not an oddity but part of an organic network, I have created URIs for a number of buildings in Pompeii¹⁴⁴ as starting point for my research. The Pleiades URI for the Iseum has been used in this work to identify the material referent that the two models (Iseum79 and IseumGT) depict. All other URIs are mostly internally minted for this purpose. When available, existing IDs have been used, like, for example, those assigned by the MANN to the fragments of frescoes and the other finds related to the Iseum. The generation of names of the 3D elements in the proof of concept is internally consistent. The Space always come first, and is the only element that can appear alone. For example Space A or Space C. The constraints that delimit a space will be identified by the abbreviated name of the space, followed by the prefix “Co” and an indication of the relative position. For example, the west constraint of Space E will be denominated SpE_CoW. Features come last and are abbreviated with the prefix “F”, They are followed by a number, as it is not unlikely that one element shows more than one feature. A feature of the aforementioned west constraint of Space E will be named SpE_CoW_F01. If the feature belongs to the space, it will be named with the same abbreviation, following that of the space. For example, a feature of space E will be SpE_F01. Transitions, abbreviated with the prefix “Tr”, include in their name both the spaces that they are connecting, in no specific order. The transition between space A and space C will be named TrA_to_C. In case there is more than one transition linking two spaces, such as, for example, the five archways that lead from the portico (SpaceA) to the ekklesiasterion (SpaceE) and viceversa, the name will be followed by a number. For example TrA_to_E01.

More complex elements had to be divided into smaller parts for modelling purposes. The parts are identified by the letter “P” necessarily followed by a number.

¹⁴¹ See further: <http://www.cyprusgazetteer.org/>

¹⁴² See further: <https://isicily.wordpress.com/>

¹⁴³ See further: <http://www.sls gazetteer.org/>

¹⁴⁴ The project of enhancing the granularity in Pleiades has been discussed by the author during CAA2016 conference.

Each single part is visible as a separate entity in the native 3DSM file. However, documenting elements to the level of their parts seemed unnecessarily detailed for the purpose of this research, therefore the parts are always grouped together under the name of the element. So, for example, the different parts composing one of the columns in the portico (SpA_F01) will be named SpA_F01_P01, SpA_F01_P02, SpA_F01_P03 and so on. But they will be only discussed and documented together as SpA_F01. Although not pursued in this proof of concept, a more granular documentation is perfectly compatible with the SCOTCH framework.

Ideally, to show the potential of the LOD documentation, it should be possible to render each of the elements (or any group of them) directly in the browser. Although technologically not challenging given the existing opportunities, developing such an API and related interface was not among the aims of this research. Therefore, the rendering of the 3D elements will be simulated with screenshots of the elements that have been uploaded on the Flickr platform, following the SCOTCH naming convention.

3.3 Conclusions

The previous chapters presented some of the most common issues in 3D visualisation of cultural heritage and proposed a new methodology for its documentation. This chapter showed the practical application of such methodology in the development of a proof of concept. The first half focused more specifically on reconstructing the CAD modelling workflow, from how the archaeological information was gathered to the specific differences among the two 3D visualisation. Particular attention was given to describing the diversity and heterogeneity of the sources, and how they impacted upon the 3D modelling and texturing process. As a necessary premise to the ontology that will be introduced in the next chapter, the ScaT dividing and naming convention for built heritage has been explained, and related to its application in the proof of concept.

4. Creation and applications of classes and properties in the SCOTCH ontology

This chapter is the the most detailed description of how the classes and properties of SCOTCH have been created and how they have been applied to document the two 3D visualisations that have been introduced in the previous chapters.

Iseum79.3DS and IseumGT.3DS, the two full 3D visualisations, developed in 3DSM and depicting the Iseum in Pompeii, can be found in the USB stick attached to the back cover of this thesis. The files and the related material can be found in folders called “IseumGT” and “Iseum79” within the folder “3D visualisations”. Both models have also been exported in .obj, with a related .mtl file for the textures in case of IseumGT, and in .fbx with embedded textures (if any). The entire documentation of both 3D models in .owl format (SCOTCHIseum.owl) can be found in the folder “SCOTCHontology”. All the 3D elements mentioned in this work can be accessed from the 3DSM models, where the different spaces are conveniently divided into separate layers, accessible and manageable from the “layers” menu, and labelled after the spaces themselves. A few very complex objects, like the tiled roofs, have required a separate layer to facilitate the modelling process, but these are still clearly identifiable according to the naming conventions described in the previous chapter. To facilitate the reading of this thesis, a simulated rendering of all the 3D elements has been created via screenshots, which have been uploaded to the online platform Flickr. The Flickr URL of the image has been used as a surrogate URI of the rendering of the 3D element. A reference to the Flickr address of the renderings of each element can be found in the complete list of elements (appendix A). All the renderings, for each element of both models, have also been added as images in appendix E, to act as a visual aid accompanying the discussion.

4.1. Spatial elements and their representations

One of the first steps in explaining the meaning and use of SCOTCH is to clarify to what elements it refers: whether they belong to the realm of the referent or that of its representations. The answer is not always as simple and self-evident as it may seem, especially when dealing with archaeological heritage or any historical object that might have been totally or partially destroyed, modified, restored, or repurposed. The line might become even thinner when discussing 3D visualisations of buildings, or other objects, that never existed in the material

world.¹⁴⁵ For example, it is easy and intuitive to recognise the ontological difference between one of the Doric columns still standing in the portico of the Iseum in Pompeii, and its 3D visualisations in the models presented here. So the chosen column (SpA_F01) is depicted¹⁴⁶ in a number of visual representations, including the files SpA_F01_79.3DS and SpA_F01_GT.3DS, which I have created. These, then, are representations of SpA_F01 (SpA_F01_79.3DS dc:depicts SpA_F01, and SpA_F01_GT.3DS dc:depicts SpA_F01). This process still sounds unproblematic when analysing representations of objects that did not survive in their materiality nor were ever recorded as actually being in situ, but can be expected to have been. An example could be the architrave of the colonnade in the portico of the Iseum (SpA_CoU_F01), depicted in the Iseum79 model (SpA_CoU_F01_79.3DS). All the surviving elements in the portico, and our knowledge of Roman architecture, strongly suggest that an architrave “must” have been sitting on the colonnade. However, the discourse becomes less straightforward when it starts including elements whose very existence is debatable, such as, for example, the second storey of the so-called priest’s kitchen (SpaceG) and triclinium (SpaceR) in the Iseum. Although the presence of stairs in the kitchen (SpaceG), still clearly visible in Saint-Non’s plan of the Iseum, convincingly points to the existence of at least one room on the upper level, nothing of it has survived, and there is definitely no evidence for a second storey of the dining room (SpaceQ.). Both hypothetical upper rooms (SpaceP and SpaceQ) are nonetheless included in my restorative 3D visualisation, Iseum79. So, what does the 3D file SpQ_79.3DS (and all its subparts) depict? What is the referent of the representation of a hypothetical space? The issue becomes even more challenging when considering places where the archaeological remains are less identifiable and less formalised than a Roman temple in the south of Italy. To address this, while maintaining a separation in the data between objects (material or not) and their representations, a distinction has been introduced in the ontology between material and speculative spatial elements.

The Iseum in Pompeii, as a material place, is associated with the Pleiades gazetteer URI¹⁴⁷ that identifies unambiguously the historical and geographical entity within a well-

¹⁴⁵ Cf., among many examples, the visualisations of the original architectural project for the Italian city of Latina discussed in *Disegnare la Città Immaginata. Latina come laboratorio di rappresentazione urbana*, or Webb (2012). *Digital Re-analysis of Lost or Unbuilt Architecture*.

¹⁴⁶ The property describing this relationship is borrowed from the Dublin Core, dc:depicts.

¹⁴⁷ <https://pleiades.stoa.org/places/793723815>

established LOD framework. To apply SCOTCH and document the 3D visualisations, however, it was necessary to draft a naming convention and a rationale, although imperfect, for assigning URIs to smaller parts. Such a convention has to include (distinguishing while maintaining on the same logical level) both elements that are still extant or that have been recorded as existing, and elements that are entirely speculative. A subtype assigning each spatial element to one of the two aforementioned categories has then been introduced (`rdf:subtype`, `scotch:material` or `scotch:speculative`) in the process of dividing the conceptual place of the Iseum into Spaces, Constraints and Transitions, as discussed in the previous chapter.

With regard to the classification of the spatial elements in the ontology, it is important to remark that:

- A material spatial element like the north wall of the portico (`SpA_CoN`) and a hypothetical one such as the north wall of the room above the triclinium (`SpQ_CoN`) have the same status within the ontology. The difference was introduced not only for the sake of transparency and clarification, but also because the different nature of these two groups of elements requires different approaches to authorship in their statements. Claiming that there is a north wall in the Iseum's portico is not the same intellectual act as claiming that there might have been second storey rooms in the private quarters. The two actions therefore need to be modelled differently.
- Declaring one spatial element as material does not imply that the statement is objective. Although the SCaT system is thought to be based (as much as possible) on geometry rather than interpretation, different readings of the same plan or of the same remains are possible. For this reason, if hypothetical elements have to be associated with an author (`scotch:hypothesisedBy`), the material ones have to be related to evidence or sources, in various formats, including pictures, architectural plans and elevations, photographs or verbal descriptions (`scotch:isAttestedIn`).
- At this level, the ontology is referring to the referent in the real world, not its representations. In this sense, it is not necessary to declare sources for the former or present look of the element, but just an author that is responsible for believing that a spatial element existed at all. Sources will later be associated with the single visual representations.
- It is not always easy to distinguish between the two kinds of spatial elements. Even though some elements, such as the pediment of the main temple (`SpC_CoU_F01`), can be

safely assumed to be there in the original temple, for the sake of rigour and transparency only items that have been actually recorded (at any point in time) to be physically on site will be labelled as “material”. All the others will be considered as “hypothetical”, even when they are extremely likely.

- Hypothetical spatial elements do not coincide with their representation. A hypothetical spatial element is a conceptual entity that can have, and usually has, a number of potential visual representations.

The spatial elements, either material or hypothetical, have all been listed in appendix A, entered as individuals in the triplestore, and assigned to their spatial category (spaces, constraints, transitions, features) and subcategory (material or hypothetical). As explained in the previous chapter, the relationship between spatial elements is often already, at least partially, expressed through the naming conventions. Nonetheless, such relationships are also formalised via SCOTCH properties.

In the documentation, each space is linked to its constraints via the property `scotch:isConstrainedBy`, and each constraint is linked to the related space through the property `scotch:isConstraintFor`. For example, `SpaceA` `isConstrainedBy` `SpA_CoW`, `SpA_CoN`, `SpA_CoE`, `SpA_CoS`, `SpA_CoU`. Each of the latter `isConstraintFor` `SpaceA`. The two properties are, obviously, inverse, and have opposite ranges¹⁴⁸ and domains. `scotch:isConstrainedBy` has `Spaces` as domain (either material or hypothetical¹⁴⁹) and `Constraints` as range, while the opposite is true for `scotch:isConstraintFor`. Likewise, a transition always has to be related to the spaces it connects through the property `scotch:isTransitionBetween`. The domain of the latter property is `Transitions`, and its range is `Spaces`. Being connected to precisely two spaces via this property is a necessary and sufficient condition to belong to the class `Transitions`.

Features are slightly more complicated entities, as the term applies to a variety of referents, from frescoes, to floors, to statues, to columns. Features are linked to their related spatial elements via the property `scotch:isFeatureOf`. As any spatial elements can have features, the range for this property is all spatial elements, including features themselves. Given

¹⁴⁸ “Properties link individuals from the *domain* to individuals from the *range*”. Cf. A Practical Guide To Building OWL Ontologies Using Protégé 4 and CO-ODE Tools

¹⁴⁹ From now on, this will be assumed and spatial elements treated as a class without mentioning its subclasses, unless relevant to the discussion.

the very general nature of its definition, it is possible that a feature, such as a niche in the wall (for example the one in the east wall of the portico, SpA_CoE_F01) has a decorative element, like a fresco. A difference has to be made between the property `scotch:isFeatureOf`, just described, and its variant `scotch:wasFeatureOf`. The former refers to a feature that is still in place, and can still be observed in the related spatial element, while `scotch:wasFeatureOf` describes those features that used to belong to a spatial element, but which have now been moved or lost. This difference will be further discussed in chapter five.

4.2. Representations and Renderings

All spatial elements discussed here, whether material or hypothetical, have at least one visual representation, including photographs, historical drawings, reports and, of course, 3D visualisations. As suggested by the W3C best practice, when possible, connections have been established with online repositories that hold a digital version of the depiction, although a distinction in the ontology has been made between the actual document and its digital version available online: the source image has a URI minted within SCOTCH, while the digital facsimile is connected to the original document through the property `scotch:FacSimile` and has its URL as URI. The digital photographs forming the archive that has been specifically built for the purpose of this research have been uploaded on the media sharing platform Flickr¹⁵⁰ and named consistently with the terminology used throughout this work.

Like all other contemporary and historical visual representations, the 3D images in the SCOTCH documentation have been linked to the corresponding spatial element via the property `dc:depicts`. The 3D representations of spatial elements created for this research are named after the spatial elements they depict, but followed by the suffix `.3DS`. The decision was driven by the use of 3DS Max as modelling software and the actual format of the files. As highlighted before, names in RDF statements can be, and often are, entirely arbitrary. This naming convention simply aims at making the names, and the rationale of the statements, understandable by a human reader. Ideally, the 3D files should be rendered in a three-dimensional environment, visualised by a 3D API. However, for simplicity, in this proof of concept the 3D rendering has been simulated via the use of screenshots.

¹⁵⁰ <https://www.flickr.com/photos/134064462@N06/albums>

Every element of both the 3D visualisations has been rendered in 3DSM, each rendering has been saved in .jpg image format (using the inbuilt archive function in 3SDM), and then uploaded on Flickr, with a consistent name. The original 3D files (consistently divided by space in the layers management menu) are always available as part of this project, and can be directly accessed and rendered in 3DS Max at any time.

These simulated renderings mirror the ontology structure. Therefore, the representation of a space (and its rendering) will include all the elements that are part of that space, such as all the constraints, the features, and the transitions that give access to it. As a consequence, some elements will be reproduced more than once. The niche in the north wall of the portico (SpA_CoN_F01), for example, will be featured individually in the rendering of SpA_CoN_F01.3DS but also as part of the rendering of the north wall of the portico (SpA_CoN.3DS) and as part of the rendering of the entire space of the portico (SpA.3DS). It is important to stress that the 3D representation (SpA_CoN_F01.3DS) and its rendering (the Flickr URL where the jpg of the rendering is stored) are two different entities and, therefore, have different URIs. The distinction between a 3D file and its rendering is not only necessary on a logical level, but also on a technological one, as any 3D file can be rendered with different settings. For this project, the same rendering, the default 3DSM one, has been applied consistently. For the sake of completeness, and to illustrate further the logic behind SCOTCH, a few additional renderings, with different settings, have been added only for SpaceC_79 (see end of Appendix E). All renderings are connected to the related 3D file via the property `scotch:hasRendering` that points at the file uploaded online. It is also important to remind that many of the constraints in the two 3D models of the Iseum are two-dimensional surfaces that can only be rendered from one point of view, and are invisible from the opposite one. For this reason, some of the renderings might seem deceptively incomplete.

This proof of concept involves the visualisation of two different moments in time: one shows the hypothetical look of the Iseum after the restoration and before the eruption, and the other shows the hypothetical look of the Iseum during the Grand Tour years. Translating this in ontological terms, many (but not all, as some were destroyed during the eruption) of the spatial elements in the Iseum have more than one 3D representation. To distinguish between the two 3D visualisations, the representations related to Roman times will be followed by the suffix 79, while the representation related to the Grand Tour will be followed by the suffix GT. For

example, the north wall of the portico (SpA_CoN) will have, in this work, two representations: SpA_CoN_79.3DS and SpA_CoN_GT.3DS. One of the important points of this proof of concept is that, theoretically, other representations of the same spatial element (or of the whole Iseum) can be related to the same conceptual space, and easily compared by the users. There is no limit to the number of variants that can be linked together, implicitly, via RDF, at the desired level of granularity.

4.3. Using SCOTCH to model authorship and facilitate citation of 3D files

There are multiple reasons behind the choice of showing two different representations of the same monument. Some are more methodological and pertain to the issue of fluidity of cultural heritage entities and their evolution. Others are more technological and are intended to test the potential of SCOTCH in encouraging both multivocality, and citation of 3D elements and their re-use in new 3D environments. In an open system in which documented 3D files can be downloaded and re-used, a researcher can decide to recycle some of the work that has been already carried out by other colleagues, together with new material created *ex novo*. Currently, such a practice would remain opaque, probably generating an understandable disconcertion in the original authors. Adopting a documentation system like SCOTCH, however, a 3D file that originally belonged to any 3D representation will be immediately identifiable as such, as it will bear and display its own metadata, even when included in a new 3D environment. In order to emphasise this potential of the ontology one of the elements appearing in Iseum79, the very well preserved oven in the so-called priest's kitchen (SpG_F01), has been imported from another visualisation of the Iseum that I co-authored in 2013, in the context of advanced training at the University of Arkansas.¹⁵¹ The 3D model of the oven, therefore, has a different representation code to that of the other spatial elements: instead of being followed by the suffix 79 or GT, it is followed by the suffix AK¹⁵² (SpG_F01_AK.3DS), which identifies the 3D visualisation developed in 2013. This specific element has been chosen from the alternative 3D visualisation because features a different author,¹⁵³ and an earlier date of creation. Its inclusion

¹⁵¹ The NEH-funded Computer games for Cultural Heritage. Jonesboro/Fayetteville, June 2013.

¹⁵² The code "AK" is arbitrarily chosen to signal the word "Arkansas" and to distinguish very clearly the three different 3D visualisations.

¹⁵³ Drew Baker, 3D tutor during my Masters and advisor for the present research. Three other elements developed by him (the doors of the main temple, the door of the purgatorium, and the main entrance door) have been documented accordingly.

in Iseum79 illustrates another application of the RDF documentation, and how practically it would deal with citation in an ideal environment in which documented 3D content is available for download and re-use, either as a whole or in its parts.

Documenting 3D visualisations with SCOTCH, each element, even separated from its original environment, would retain all the information about its sources, enabling other researchers to verify the information and decide whether or not that representation is reliable and suitable for their own line of research. The new author will not have to re-create statements about the documentation, as the original ones would be still valid. In the SCOTCH documentation, each 3D representation of a spatial element has a relationship to the 3D environment to which it belongs (`scotch:isPartOf`). Some elements, such as the 3D oven in the kitchen of the temple (`SpG_F01_AK.3DS`), will belong to more than one 3D environment: Iseum79, and IseumAK. For this reason, the property `scotch:isPartOf` is not unique, although it is transitive¹⁵⁴. Therefore, if a 3D visualisation, like any of the aforementioned representations of the Iseum in Pompeii (Iseum79, IseumGT or even IseumAK), were to be included in a larger 3D environment, such as a hypothetical 3D visualisation of the entire *Quadruportico dei Teatri*, then all the elements that are part of the Iseum's representation would be automatically also part of the new, larger one.

This approach also facilitates the transparent use of stock 3D elements, available in either online or offline repositories. A selection of architectural elements for specific periods of time or artistic styles are commonly available from commercial companies,¹⁵⁵ as well as assets produced (for different purposes) by other users and made available on platforms such as Unity 3D assets store¹⁵⁶ or Sketchup 3D Warehouse¹⁵⁷. These assets are sometimes locked and sometimes customisable, allowing, for example, modifications of the ratio between the parts of a column or another architectural element. Through SCOTCH, it is possible to identify the provenance of such 3D elements, to state authorship, and to assert that the element was part of another 3D environment, even if one that was not complete or semantically defined, but simply a stock. The practice of re-use does not imply that the researcher must accept or reject a 3D

¹⁵⁴ If A is part of B and B is part of C, then A is part of C.

¹⁵⁵ Such as, for example, Turbosquid (<http://www.turbosquid.com/>) or CG Trader (<https://www.cgtrader.com/>)

¹⁵⁶ Available at <https://www.assetstore.unity3d.com/en/>

¹⁵⁷ Available at <https://3dwarehouse.sketchup.com>

element. If modifications occur, SCOTCH (and common sense) prescribes that the original author must always be acknowledged, along with the provenance and the nature and extent of the modifications. In SCOTCH, the modified 3D file will have a new name that is consistent with the current 3D environment, but it will have as its source the original stock 3D model. It will be up to the modeller, based on the reliability of the original 3D source and its documentation, to decide if that element has to be considered as a type of scholarly reference or more as a decorative addition for communication purposes.

Among the RDF statements describing a specific 3D representation, one of the critical ones is that of authorship. A crucial assumption of this documentation practice is that researchers creating 3D models are not worried about their work being appropriated and/or misused, but simply see re-use as a citation of their work in someone else's research. This scenario also assumes the good faith of all people involved in this interchange, and a basic level of intellectual honesty. Although the same point could easily be made for almost all disciplines in academia, this issue seems to be a special concern of 3D modellers, and still feels like one of the major objections to making academic 3D visualisations open. In the presentations of his large project Rome Reborn, for example, Frischer put a special stress on the impossibility of downloading any part of the large scale model, and the debate on how to embed watermarks in 3D digital cultural heritage is still very lively (Koller et al. 2009, Stanco et al. 2011). However, intellectual theft might always happen, in one form or another, and 3D modelling is no exception. Hiding the original author of a 3D file is as easy as stealing another researcher's idea or formula. However, 3D visualisation being a field where the contributions are often developed by commercial companies¹⁵⁸ that have interests in defending their assets, the concern might have grown unnecessarily. Moving towards a specifically academic 3D visualisation should help to leave behind the idea of "protecting" the outcome of research. If documented 3D visualisation became the quality standard in academia, then concerns about authorship should feel substantially less compelling. Ideally, a well documented 3D model could, by all means, be the starting point of a subsequent project, possibly re-modelling or building *ex novo* specific elements if different sources and interpretations need to be highlighted. Building on top of previous (vetted) research would allow 3D visualisations to grow, mature, evolve, and

¹⁵⁸ Cf., for example, the 3D content created for the Virtual Museum of Herculaneum, developed by the commercial company Capware, or the cultural heritage projects developed by the Noreal company.

have a lifecycle more closely aligned to traditional academic outputs. In the environment described above, which is not yet reality but is far from impossible, re-use is not only permitted, but encouraged and even considered best practice.¹⁵⁹

4.4. Modelling different Source Types in SCOTCH

As the literature shows (Niccolucci 2012, Koller et al. 2009), the attention of the academic community is increasingly focusing on how to represent the value of uncertainty of a 3D model or its parts. Looking at projects like the the 3D visualisations of the Oplontis Villa, *The Roman Forum* or *La Valle degli Imperatori*, the solutions most often suggested tend to assess certainty on a quantitative basis, e.g. labelling elements as “very likely”, “probable”, or “speculative”. Although this is certainly a useful step towards greater transparency, three very broad categories still appear inadequate to capture the complex relationship between a scholarly 3D visualisation of ancient heritage and its sources with their different natures. Moreover, the criteria of the assessment of the degrees of “certainty” of an element still remain opaque and subjective. Rather than a quantitative approach, based on how reliable or “certain” an element in a 3D visualisation should be considered, SCOTCH suggests a qualitative one, based on the attestation of the sources that have been consulted. For this reason, the entire SCOTCH ontology pivots on the property `scotch:hasSourceType`, which aims at defining the relationship between the information delivered by the 3D representations of the spatial elements in the model and the variety of sources from which that information is derived. The premise for the use of this property is to assign a different URI to each source, from bibliographical citations to first-hand documents produced on site. Each source is then assigned to a type category, through `scotch:hasSourceType`. From a formal point of view, `scotch:hasSourceType` has all the sources entered in the triplestore as domain, and the types of sources defined in SCOTCH as range.

In this proof of concept, the class of `SourceTypes` allows seven values, here described and analysed. However, additional values can be identified hypothetically and added to the vocabulary at a subsequent stage, especially in the context of different applications of the ontology, for example outside academia. It is important to stress that, consistently with the qualitative approach advocated, these values are not hierarchical, and the ontology is not intended to suggest that one type of source is preferable to or more reliable than another. In

¹⁵⁹ As, indeed, already suggested in the London Charter.

other words, the SCOTCH ontology moves from levels of certainty to types of sources, where the type is not defined according to its (alleged) reliability, but simply according to its different provenance and nature.

Here follows a description of all the different source types.

scotch:hasSourceType, scotch:Primary

Class definition of scotch:Primary: “The material referent of the digital representations still exists, and its dimensions and/or position have been measured and published”

To this class belong the primary sources that document and describe material referents still standing in situ. The measurements, however, have to be public and available either digitally (such as the first hand measurements taken on site for the purpose of this research and uploaded online¹⁶⁰) or as traditional publications (such as, for example, the measurements of the portico and ekklesiasterion of the Iseum mentioned in De Caro 1992). The ontology does not imply that hard measurements are necessarily more accurate or less biased than the information derived from plans, drawings, or other secondary sources. Whoever has undertaken the task of measuring an archaeological site knows how often human mistakes happen, either during the measuring or the transcribing processes. Assigning a source to this category mainly states two pieces of information about it: the material referent of the digital representation has been recorded, and it still exists. Therefore, any researcher has, potentially, the opportunity to challenge the information and take new measurements in situ.

It is important not to confuse the authorship of the source with that of the 3D representations. The authorship of the source is stated through the established DC property dc:creator. To avoid, or at least limit, confusion, the authorship of the 3D representation is expressed via another property, SCOTCH specific scotch:3Dcreator. The use of scotch:3Dcreator also allows the bypassing, partly, of one of the most common issues of RDF ontologies, known as “reification”. Reification¹⁶¹ is often used as a strategy to overcome a major limitation in the modelling of information through RDF statements, i.e. to express information

¹⁶⁰ Digital scans of the measurements taken on paper have been uploaded on Flickr, and considered a surrogate of publication.

¹⁶¹ The concept of reification and how it is approached in SCOTCH will be discussed in a subsequent paragraph in this chapter.

about the statements themselves. In other words, the process of reification is about creating RDF statements about RDF statements.¹⁶² The context of a scholarly documentation of 3D visualisation, in fact, requires that the association between a digital three-dimensional representation of an element and its sources also indicates an author and a date. These two pieces of information make the RDF documentation closer to a traditional academic publication. However, the SCOTCH framework assumes that the person creating the 3D file (scotch:3Dcreator) is also always responsible for the association between the 3D representation and the related sources. Likewise, the creation date of the 3D element (dc:Date) is also assumed to be the date of publication, in a broad sense, of the statement about the sources used as references. This identification of the creator of the 3D representation with the author of the association between representation and sources is perfectly consistent with SCOTCH premises. In this knowledge model, the majority of the statements do not pertain to the nature or the look of the material referent, but to its specific representations and the research process on which they rely. No actor other than the author of the 3D file can actually declare what sources have informed the look and the other qualities of a given 3D representation. This view does not diminish SCOTCH's multivocality. On the contrary, a diversity of approaches to, and readings of, the same spatial elements remains one of the most stimulating possible applications of this ontology. Other authors and 3D modellers are strongly encouraged to develop variant representations that will all be linked to the same conceptual spatial element. Each of them will be related to its own sources. In each case the 3D creator will also be the person responsible for the statements about the sources on which a 3D representation is based.¹⁶³

Sources belonging to the scotch:Primary class will be connected to the related 3D representation through the property scotch:isEvidenceFor (inverse of scotch:hasEvidenceIn), with all the sources as domain and all spatial elements¹⁶⁴ as range.

scotch:hasSourceType, scotch:Secondary

¹⁶² CF. 3WC RDF Primer "RDF applications sometimes need to describe other RDF statements using RDF, for instance, to record information about when statements were made, who made them, or other similar information (this is sometimes referred to as "provenance" information)."

¹⁶³ In theory, further comments are always allowed thorough annotations using, for example, the Open Annotation framework.

¹⁶⁴ More precisely, the range of this property, as that of all the other properties related to source types, is not the spatial elements but their dimensions. The concept will be introduced and explained in the following paragraph.

Class definition of `scotch:Secondary`: “The material referent does not exist any more or has been subsequently modified, but it has been documented in the past and the documentation is still available. Or

The material referent still exists but information has nonetheless been derived indirectly from secondary sources”.

To this class belong the secondary sources, both visual and verbal, describing pieces of cultural heritage that have been lost, destroyed, modified or heavily restored. This is the class of documents most frequently used as a reference for the development of the IseumGT model, the latter being a 3D visualisation of how the place might have looked in the eyes of the witnesses during those years.

Initially, the distinction between classes of sources was driven by the relationship between the document and the material referent. Therefore, the difference between assigning a source to the class `scotch:Primary` or `scotch:Secondary` sometimes lay in the status of the material referent: if the latter was still standing, then the source would belong to `scotch:Primary`, otherwise to `scotch:Secondary`. Subsequently, it became clearer that classes based on the relationship between the sources and the 3D representation of the referent would have been more consistent with the SCOTCH framework. Therefore, the identification of a source’s class shifted towards its role as provenance for a specific piece of information. Having in mind the experience of measuring an ancient artefact for the purpose of producing a virtual representation, it is easy to realise that some of the elements that are still in situ are not always accessible during the survey, and that first-hand measurements (especially of the very thorough and precise kind that is required during a 3D modelling process) are not always published. Not to mention that resources to perform a survey, in terms of time, money, access, are sometimes unaffordable. In those cases, the most natural approach among 3D modellers is to rely on secondary sources, such as architectural plans, cross sections and elevations, even for those elements that are not lost but are, at that moment, simply not accessible to the 3D author. Therefore, even 3D representations of elements that could theoretically be measured in situ have been modelled according to sources of the type `scotch:Secondary` when first-hand data was missing.

The SCOTCH ontology has intentionally chosen a naming convention that avoids, as much as possible, the implication of a hierarchy among types of sources, or a progression in

their quality. It is impossible not to notice, though, that the labels “primary” and “secondary” inherit strong semantic connotations in this sense. However, the clarity and familiarity of the terms used as labels has been considered a more important quality. The naming choice by no means reflects the idea that, for example, the information derived from a scaled document drawn by Piranesi in the eighteenth century (scotch:Secondary) is less reliable and/or less valuable than my hard measurements (scotch:Primary) of the same object, but simply states a difference in their nature and their role as provenance¹⁶⁵. The kinds of sources a researcher has relied upon in the process of producing a 3D visualisation is specific to each single work, and the aim of SCOTCH is to document how that given model was created and the nature of its informational context.

The SCOTCH LOD documentation can be also used, of course, as a guideline or compass by other modellers who are looking for sources to build their own representation of the same cultural heritage object (or a similar one). Moreover, new sources can always be added, by any user, as depictions of a spatial element. However, the general information about the ancient place (and its depictions and descriptions, digital and analogue) does not coincide with the information about the single 3D representation. The sources linked to a spatial element, such as, for example, the niche in the east wall of the portico (SpA_CoE_F01) are not necessarily (or not all) the sources that will be linked to one of its 3D representations (SpA_CoE_F01_79.3DS or SpA_CoE_F01_GT.3DS). Stating that a document has been used as reference for a 3D representation does not imply that such a document is considered, by the 3D author, the only or even the best source for a representation. It simply states (or, better, documents the fact) that the document was actually the source for a particular 3D visualisation. If a 3D author finds that the information used as reference in a 3D model is disproved by better and more accurate sources, they can deprecate their representation, and create a reference to the new source of information. This would not erase the record that connects the original deprecated version of the representation with the related source that was stated at the time of its publication. This approach not only enhances the transparency of the 3D model, but also augments the potential educational value that a documentation process holds when all the methodological steps are recorded, including those that are subsequently rectified.

¹⁶⁵ It is undeniable, though, that the higher number of operations and hands involved in the former (measuring the object, drawing and inking a scaled plan, digitising and tracing it in SVG format, importing and rescaling the plan in a 3D environment, measuring it) makes mistakes more likely to happen.

All sources that belong to the class `Secondary` are linked to the related spatial element via the property `scotch:isReferenceFor` (inverse of `scotch:hasReference`), along with the canonical bibliographical information, modelled in accordance with the Dublin Core standard.

`scotch:hasSourceType`, `scotch:Derived`

Class definition of `scotch:Derived`: “The material referent does not exist any more but information can be reasonably derived from material clues”

To this class belong the pieces of information that come from the intellectual process of analysing and interpreting signs and clues, usually, but not only, in the material remains. The height of a no longer extant roof, for example, can be derived from a change in the pattern of the surviving wall, in either the masonry or the decoration. Looking at the Iseum’s visualisations, the width of the door of the Purgatorium (`TrA_to_T_F01`) is based on the width of the related threshold (`TrA_to_T`). Therefore, the dimension of the door is connected to the dimension of the threshold via `scotch:isDerivedFrom` (whose inverse is the property `scotch:Derives`). No source can be allowed in the `scotch:derived` class unless it has a valid `scotch:isDerivedFrom` property pointing at another element in the 3D visualisation or to an external reference documenting the material clues.

This kind of source is more frequently used as a reference in 3D visualisations of ancient heritage than non-experts may think. The process of deriving missing information from what is already known (to fill a gap or just to speed up the workflow) is so natural to 3D authors that it risks going completely undocumented. It may, for example, seem unnecessary to record that all six Corinthian capitals of the pronaos of the main temple are assumed to be of the same dimensions and shape, although only two of them partially survive and are still visible in situ. However, as the comparative analysis of visual documentation of the Iseum in Pompeii shows, what is apparent in the eye of one scholar might not be seen in the same way by another. Moreover, new information can arise and shed a different light on what appeared previously to be a sensible assumption. Above all, intellectual transparency requires that even choices and processes that seem obvious to the author must be documented, forcing the modeller to be explicit about their reasoning process, and thus achieving a more rigorous workflow and a more useful knowledge model.

scotch:hasSourceType, scotch:Guessed

Class definition of scotch:Guessed:

“The material referent does not exist any more and it has not been documented, but it can be visualised according to a citable source, like well accepted standards, precedents or previous scholarship”.

This type of source is largely employed during the process of research undertaken by 3D authors to develop restoration hypotheses about cultural heritage. Even in cases of relatively well preserved monuments that have also been studied and represented many times, like the Iseum, it is unlikely that a researcher has all the information needed for a complete 3D visualisation of the entire space. Front views, for example, are more common than rear ones. In the case of temples, studies of the exteriors are more likely to be produced than studies of the interiors. As many virtual archaeologists stress (Hermon 2008, Baker 2012), there is always a component in a 3D visualisation that is hypothetical. But, in a scholarly context, the guess has to be as informed as possible. The analysis of similar (in time or space) buildings, the application of quite established canons and the study of previous scholarship are three of the most common strategies to fill gaps in information, in 3D visualisations as well as in most of the humanities disciplines. This class probably being the broadest one, and possibly the most frequently used, a division into three subclasses has proven useful: scholarship, canon, precedent. The three categories are based on the actual sources consulted during the documentation of this proof of concept. Further, or improved, subclasses could be added at a future stage.

The Doric columns in the Iseum’s portico (SpA_F01 to SpA_F26), for example, look unsurprisingly similar to those belonging to the Portico of the Stabian Baths. The two buildings are not only located in the same area of the city of Pompeii, but were also restored in the same years, after the earthquake in 62 BC. Lacking any obvious¹⁶⁶ material clue about the height of the portico’ cover (SpA_CoU_F03), the height of the one in the Stabian Baths¹⁶⁷ has been used as a reference in Iseum79 (type:guessed, subtype:precedent). Another option could have been

¹⁶⁶ Or, at least, obvious to me.

¹⁶⁷ VII.1.8.

to derive the height of the roof from Piranesi's cross-sections, using his restoration hypothesis as a guideline. In this case, the source would have been type:guessed, subtype:scholarship, instead. However, this proof of concept was meant to challenge the documentation framework, more than to display a convincing hypothetical restoration or develop a 3D visualisation consistently based on the work of a single scholar. Therefore, the choice of sources has sometimes been driven simply by the maximum heterogeneity, testing, in a sensible way, as many different options as possible against SCOTCH.

Last, to the class subtype:canon belong those sources such as architectural and decorative canons, both contemporary with the monument (such as Vitruvius' books of architecture) or developed in subsequent scholarship through the analysis of artefacts (such as the codification of Pompeian painting styles drafted by Mau). Sources belonging to this class are connected to the 3D representation through the property scotch:isBasedOn. This property has the sources belonging to the scotch:Guessed class as range, and a different domain according to the specific subclass. In the case of precedent, the triple will point at the object(s), either existing in real life or only through documentation, that are suggested as relevant comparisons. They could be identified through name, spatial coordinates, historical and contemporary documentation or museums' catalogue numbers. In the case of canon, the triple will point at a bibliographical reference, e.g. the Books of Architecture by Vitruvius. In the last case, scholarship, the triple will point at another scholar's visualisation hypothesis, either as an image (like one of Piranesi's drawings) or as a piece of research in textual form (like an article, paper or book).

The 3D representations in this proof of concept are rarely based on a single source. Each element can have more than one scotch:isBasedOn relationship. Referring to multiple sources can strengthen a hypothesis. If additional sources can be mentioned, they will reinforce the argument around a 3D visualisation. Moreover, comparing different sources for the same element may suggest relationships between documents. For example, the height of the front door of the temple of Isis is based on a source type:guessed, subtype:scholarship because the value has been derived from Piranesi's elevation of the temple. However, Piranesi's calculations match quite closely the standard suggested by Vitruvius (Books of Architecture, Book 4, Chapter VI).

The aperture of the doorway should be determined by dividing the height of the temple, from floor to coffered ceiling, into three and one half parts and letting two and one half thereof constitute the height of the aperture of the folding doors. Let this in turn be divided into twelve parts, and let five and a half of these form the width of the bottom of the aperture.

Therefore this component could have an additional source type:guessed, subtype:canon, with reference to Vitruvius. The similarity could be mere coincidence, or it could mean that the artefact, measured by Piranesi from its plaster cast now lost, matched Vitruvian guidelines. It could also be hypothesised that the knowledge of Vitruvius' books was part of Piranesi's training, and that he referred to that source when material evidence was lacking. In any case, such information seems sufficiently relevant to be preserved in the documentation. When all the sources are at the same level in the eye of the 3D modeller, they can all simply be linked to the digital representation. When one is assumed to be more important, though, the additional source(s) will be connected through the property `scotch:isSupportedBy`, provided, of course, that they are consistent. Besides the personal preferences of the 3D author, acknowledging the existence of contradictory sources will enhance the transparency of the process, giving other researchers the opportunity to make different decisions based on the same documents. In this case, the property used will be `scotch:isNotSupportedBy`.

`scotch:hasSourceType`, `scotch:Speculative`

Class definition of `scotch:Speculative`: "The material element does not exist any more, but it can be visualised according to the researcher's experience, knowledge, or intuition. However, no citable source can be identified."

At first, this definition may sound very vague. Concepts like "intuition" or "experience" can hardly be quantified or measured. Moreover, if it is not possible to cite any specific material object, bibliographical reference or scholarly literature, then the entire idea of documentation appears to fade away. Nonetheless, a trained eye, used to analysing and identifying specific patterns, can estimate ideal-typical shapes and proportions with a certain reliability, even when it cannot actually point at any specific comparanda. Another methodologically more relevant

objection is that it is not the aim of the ontology to assess the reliability of the sources, but only to give information about their nature. Therefore, SCOTCH's goal is to document the provenance of the information in the most accurate and precise way, and to let the users know that there are elements in the visualisation that, although possible (or even probable), do not refer to a specific, citable source.

As for the other kinds of sources, the actor that establishes the connection between the 3D element and the provenance information is assumed to be the author of the representation itself. However, in the case in which the modeller is also the author of the source (in the sense that it is based on their own experience or training), authorship has been addressed differently, treating the informed speculation as a document, with a URI¹⁶⁸, and classic DC metadata.

For example, the height of the walls of the temple of Isis in the years of the Grand Tour is fairly complicated to establish. Different visual sources suggest different looks, and different degrees of damage.¹⁶⁹ Therefore, I have decided to model those walls according to some reasoned balance among the different sources. It being impossible to point precisely at any of them, I have indicated the source for the walls of the temple of Isis in the IseumGT model (SpaceC_GT) as type:Speculative. A resource has been created, as an abstract concept with an arbitrary name (for example: hypothesis#1), and has been associated with an author (myself) and a date of publication. This speculative source has then been connected to elements like SpH_CoW_GT.3DS.

This approach also covers cases (absent in this proof of concept) in which the 3D modeller is crediting an intellectual contribution or insight of another researcher that is not published or citable in any way. In cases in which further discoveries disprove the hypothesis, the information can be deprecated or commented upon.

scotch:hasSourceType, scotch:Contextual

Class definition of scotch:Contextual: "The digital element has been added for aesthetic and communication purposes, but still within the boundaries of the general historical knowledge of the context "

and

¹⁶⁸ Adopting by necessity a process of reification.

¹⁶⁹ This could be attributed to inaccuracies during the drawing process as well as to provisional restoration processes that it underwent in those years.

scotch:hasSourceType, scotch:Fictional

Class definition of scotch:Imaginative: “The element has not been created for a scholarly purpose and does not aim at historical accuracy. However, some characteristics of a historical referent can still be recognised.”

There are, theoretically, no limits to how speculative an element in a 3D visualisation can be. Scholarly virtual environments can have different purposes and can feature components that are artistic, ludic or narrative. A gamified element can be introduced to make the historical and archaeological content more appealing to a non-expert audience.¹⁷⁰ In some cases, the narrative element is the main purpose of the academic project itself and the historical environment just a background¹⁷¹. There is no *a priori* judgement to be made on the kinds of elements an author decides to introduce in the 3D visualisation, as long as their sources are stated unambiguously and included in the documentation.

Elements such as the Nilotic birds that appear in some traditional and contemporary visualisations of the Iseum (for example, in Ill. 7), and which may or may not have lived in the architectural complex and been used during the mystery cult, can contribute to contextualising the buildings and making them look more lively and less artificial. There is no evidence, at least of which I am aware, of exotic animals' remains in the Iseum or in other Isiac sanctuaries in Italy. Researchers may find the hypothesis highly improbable, considering the actual space of the Iseum. In any case, what is crucial is that this kind of information is always identifiable and, possibly, isolated from the rest of the 3D visualisation, if needed. As for all other sources that do not have any possible bibliographical reference, or any external document to point at, but which rely on the expertise and judgement of the author of the representation, a statement about authorship is necessary, following the procedure described for the type:Speculative sources.

4.5. Introducing the concept of Components the enhance the level of granularity in the documentation

¹⁷⁰ On the relationship between video games and archaeology cf., for example, the work of Erik Champion. For the use of video games to display historical data, cf. for example, the work of Robert Warren in the framework of the WWI historical project *Munnin*.

¹⁷¹ In the case of the popular game *The Last Express* (1997), recently republished for mobile devices, the accurate reconstruction of the interiors of a Victorian-era train is part of the charm, but by no means the main purpose. Most of the attention of the gamers is meant to be attracted by the unusual interactive narrative.

It is often suggested, even by one of the founders of virtual archaeology, Niccolucci (2012), that 3D visualisations of cultural heritage could enhance their intellectual transparency by dividing all the elements that have the same level of certainty, and grouping them into separate layers. In this way, users could visualise the elements by selecting only the kinds of provenance they are interested in. The hypothesis, captivating in its linearity, actually hides and over-simplifies the nature of both cultural heritage and its digital representations. Leaving aside the objection about the concept of «certainty» (which has already been discussed), the idea of separate layers in a 3D visualisation involves a number of logical and practical flaws. First, it is unlikely that the representation of an ancient space, or even of a single one of its elements, is based on only one source. It is certainly not the case for research around Pompeian buildings. Being more precise, even the information about the different dimensions¹⁷² of a single element might come from separate sources. Looking at the ekklesiasterion in the Iseum (SpaceE), for example, the north wall (SpE_CoN) has been measured lengthwise in situ. The height, however, has been derived from Piranesi in the Iseum79 representation, and approximated from the documentation of the frescoes for IseumGT. The width of the wall¹⁷³ could not be measured, but it has been assumed to be consistent with the width of the east, arched wall (SpE_CoE), which could be measured through the arches.

To capture this complexity in the ontology, each 3D representation has been divided into something that has been called, generically, a “component”. `Scotch:component` has been introduced as a class grouping everything that is, in some way, part of the 3D representation of an element. Types of components mostly include dimensions and textures. The first class is subdivided into the classic height, width, length, and circumference. In this way, it is possible to relate a selected source to the specific dimension, instead of the whole element. In this proof of concept, components are named by adding the suffix `Cm` to the name of the representation of an element, plus `#n`. The number assigned to the component is not semantically relevant.¹⁷⁴ So, for example, the height of one of the columns of the pronaos in the Iseum79 model is `SpA_F01_79.3DS_Cm#2`. The value of this entity is based on a particular secondary source (`scotch:hasReferenceIn`), Piranesi’s elevation of the Temple of Isis. The management of the 3D

¹⁷² Most commonly: length, height and width.

¹⁷³ More precisely: the distance between the two surfaces.

¹⁷⁴ Although, just for my convenience during the data entry process, I have usually assigned #1 to length, #2 to height and 3# to width.

elements to the level of components in the documentation also makes it possible to record the value of the main dimensions of each 3D element, increasing substantially the potential longevity of the 3D file.

In this project, the 3D features have been measured through a built-in function in 3DS Max. The tool builds a wireframe solid around the selected feature, and displays its dimensions in a dedicated window. In other words, it calculates the length, height, and width of the most extreme points of the object. For some of the spatial elements, this is definitely a simplification. However, in this proof of concept, the whole visualisation is meant to remain rather basic, and closer to a mass model than a detailed representation. Other users, who want to take the documentation to a higher level of granularity, can divide the 3D representation into smaller and simpler “parts” (another possible component) and assign dimensions to each one. The process can be replicated *ad libitum*. As often happens during the modelling process, all the elements that were more complex than a single facade have been created by assembling subparts. For example, each column in the portico is made of seven components in order to obtain the final geometrical shape. However, all the parts (named through the suffix P01, P02 and so on, at the end of the name of the 3D representation) are only visible in the source 3D file. They have been grouped¹⁷⁵ for convenience, and each 3D element has been considered only at the unit level. From an ontological point of view, it should be noted that components are allowed to have components¹⁷⁶. Therefore, for example, it is possible within SCOTCH that parts, which are components, have their own dimensions, which belong to the class of components as well (although to a different subclass).

The point to be stressed is that virtual archaeologists have to harmonise different kinds of sources, trying as far as possible to be consistent. The final outcome of many 3D visualisations gives a false idea of homogeneity that this approach to documentation wants to discourage. Instead it aims to show the complexity of the process, even if this often means declaring the unreliability, or absence, of the sources.

Scotch:components also allow SCOTCH to deal with different levels of granularity that suit different projects, and facilitate collaboration, recycling and re-use of previous work. It is not possible to set a general level of granularity appropriate for every project. However, using the

¹⁷⁵ “Grouping” in 3DS Max allows to create a single entity made of different, smaller ones. After having been grouped, the original subparts can be accessed only in the source file, once they have been “ungrouped”.

¹⁷⁶ In the same way as features can have features.

concept of components, a researcher may deconstruct an existing 3D element, further dividing it into its subparts, and dealing specifically with the dimensions (or textures) of each of them. Theoretically, the class of dimensions not only includes the aforementioned length, height, width and circumference, but also a number of other measurements, such as, for example, inclination or curvature. They were, however, not considered relevant to this proof of concept and have therefore not been included in the ontology at this stage.

Components proved to be a useful concept for dealing with a very specific aspect of 3D representations that very often goes completely undocumented: textures, i.e. the images that, in a 3D model, are rendered on a surface. The 3D visualisation Iseum79 is an untextured model. On the contrary, IseumGT not only displays textures, but these also have historical relevance. The case of IseumGT highlights how crucial it is to attach provenance information to textures. The representation of the west wall of the ekklesiasterion, for example, (SpE_CoW_GT.3DS), has a component of the type textures (SpE_CoW_GT.3DS_Cm#5). The texture has an author and a date (in this case me, and 2016), and it is connected to the source image (in our example, Image#20) through `scotch:isBasedOn`. The source image (in the case of IseumGT always one of the secondary documents) has, of course, its own author, date and publication details¹⁷⁷.

4.6. Documenting simplifications

One of the aims of the ontology is to give an account, in a synthetic and standardised way, of the several little (and not so little) adjustments that 3D authors perform during the modelling process. These might be perceived as self-evident by the authors of the visualisation but, especially for this reason, they need to be recorded for transparency and consistency. The idea of a perfect reproduction, even of monuments that are still standing, is a misleading one: it is simply impossible to measure every single point of an artefact and reproduce it in a digital environment. The fact that a model is always a simplification is somehow embedded in the concept of a model itself (Hermon 2008). Nonetheless, the more the 3D visualisation tends to be immersive or realistic, the more this basic assumption risks being forgotten.

The level of simplification applied is specific to each particular project and meets the different needs of each visualisation. However, even considering the necessary variations in

¹⁷⁷ Image#20 in this triplestore corresponds to: Chiantarelli, G. (illustrator) & A. Cattaneo (etcher) West wall of the ekklesiasterion in the Temple of Isis in Pompeii. Published in Elia, O. 1941. *Le pitture del Tempio di Iside*. Roma.

granularity, part of the process can be generalised and modelled in SCOTCH for documentation purposes. The first common strategy of systematic simplification can be found in the process of measuring the material place. Unless the author has unlimited access to the monument they are representing, the surveying process is something that has to be optimised according to the available resources, such as people, time, access, light conditions. Hence, it is necessary to prioritise and make choices. Measuring the Iseum in Pompeii, my strategy was, when the spaces looked fairly regular, to measure only the constraint on one side, assuming that the opposite one was identical. For example, the length of the south wall of the ekklesiasterion has not been measured, as I assumed (artificially) it mirrored perfectly the north one that I had measured already. As a consequence, although the two dimensions have exactly the same value, the length of the north wall in both IseumGT and Iseum79 models is connected to a primary source through the property `scotch:hasEvidenceIn`, while the length of the south wall is connected to the length of the north one through the property `scotch:isDerivedFrom`. Likewise, only one of the surviving columns of the portico has been measured: the one at the north-east corner (SpA_F01). It has been chosen because it showed the best status of preservation and the highest amount of surviving stucco decoration. It appeared to be the best suited to give an impression of the look of the columns in 79 AD, although none of the original capitals has survived today in its entirety. All the other columns have been considered identical to the one measured, and perfectly aligned with it. Therefore, only the measured column (SpA_F01) is connected, via `scotch:hasEvidenceIn` to a primary source. All the others, refer to SpA_F01 through `scotch:isDerivedFrom`.

It is an objection to 3D visualisation that the represented monuments are geometrically perfect, in a way that contradicts our everyday experience of contemporary buildings and, even more, of ancient ones. Their artificial evenness, consistency and alignment give to the 3D models an undeniable flavour of hyper-reality. However, what may be considered a failure in the attempt to “rebuild reality as it was” can be seen as a useful reminder of the synthetic and abstract nature of 3D models as representations. In this perspective, it is crucial to document simplification and regularisation, so that the inevitable loss of data in the representation is recorded and the user can be redirected, when possible, to more detailed sources of information.

A different common case of simplification is the normalisation of dimensions of elements

that belong to a series. The five arches at the entrance of the ekklesiasterion (TrA_to_E01 to TrA_to_E05) have been measured individually, by me, in all their dimensions, and that information is available in the documents I have produced and published online.¹⁷⁸ However, reproducing the little differences that make each of the five transitions unique was not the level of precision that my visualisations were aiming for. I have then decided to normalise the measurements and produce (and replicate) a standard arch, based on an average of the recorded measurements. All the arches have evidence in primary sources, as they have each been measured, and the measurements have been published. However, they also show the property `scotch:isNormalised`. The only value of `scotch:isNormalised` currently allowed in this version of the ontology is `average`. A comment may give more information about the original measurements, which, in any case, can always be accessed via the `scotch:hasEvidenceIn` property.

4.7. The issue of Reification and how it is managed in SCOTCH

As proved by a number of successful projects, the use of RDF and LOD in academia is a powerful and effective way to allow interactions and interchanges. However, when used to encode rich or fuzzy information it also reveals some of its limitations. If the simple three-words approach of RDF is ideal in a commercial environment, it sometimes feels not completely adequate for complex scholarly statements. In particular, for RDF to be as close as possible to academic publications, it is important that each statement displays information about an author and a date. This concept, which sounds misleadingly easy and straightforward, is actually one of the most common bottlenecks in the use of RDF. It is relatively easy to attach different kinds of information (as statements) to objects, saying, for example, that a document has an author, that it has a year of publication, that it is held in a specific library, and so on. However it becomes substantially more complicated to say that a particular individual is stating such information. In other words, that a certain document X has a title Y, but according to actor Z. RDF is prepared to make statements about things, but does not allow, formally, to make statements about statements, i.e. to write metatriples about the triples.

The problem, already introduced in this chapter, is well known, and it is tackled in different ways in different communities, according to different research requirements. One of the most

¹⁷⁸ Available on Flickr repository at <https://www.flickr.com/photos/134064462@N06/30454311404/in/dateposted-public/>

common ways to deal with it is a process known as “reification”. Using this approach, the RDF statement that needs to be commented upon (or receive an authorship attribution), is given a URI, so that it essentially becomes an object in itself, and, as such, can have statements referring to it. This solution, however, is not unproblematic. Using reification can trigger an avalanche effect: it involves the creation of a large number of additional triples, making search more complicated and the whole triplestore heavier and less functional.

Each reified triple, in fact, needs to receive a URI and to be identified as a statement via another statement (type:RDF statement). The triple’s subject, predicate and object then need to be defined, always via other RDF triples. The process of reification of a triplestore, for academic purposes, is discussed, for example, in the digital prosopographical project snap:dragon¹⁷⁹. The snap:dragon team decided to approach reification with the use of Open Annotation (OA). After the statement, and its part, have received a URI, an annotation (oa:body), usually stating author and date for the RDF triple, is associated with the latter (oa:target). Although flexible and relatively simple, the OA approach does not really solve the issue of generating a substantial number of extra triples.

Modelling SCOTCH, one of the criteria in the creation of classes was to avoid reification of statements as much as possible. Although perfectly accepted in the field, this practice would probably diminish the accessibility and usability of the documentation process, especially for users not familiar with RDF logics. As anticipated in previous chapters, avoiding reification to a certain extent was possible, within the SCOTCH framework, due to the specific nature of its domain. The most frequent subjects of the statements allowed in the SCOTCH ontology, in fact, are digital entities created by a 3D author. It seems safe to assume that, if a researcher creates a 3D representation, and that 3D representation has a property describing its sources, the person responsible for that statement can only be the author of the representation itself.

However, there were cases in which making meta-statements was inevitable, for example when declaring a relationship between a spatial element and one of its former features (via the property scotch:hadFeature). Stating that an artefact, like a statue or a piece of fresco, used to belong to a particular space or other spatial element, is something that needs at least a reference. Moreover, these statements are the kinds of topics on which different researchers

¹⁷⁹ See further: http://snapdrgn.net/wp-content/uploads/2014/01/SNAPDRGNCookbook_1.01.pdf

may disagree.¹⁸⁰ To deal with this need in the documentation, a different method has been preferred to traditional reification. When comparing strategies to create statements about RDF statements, the approach described by Nguyen, Bodenreider and Sheth 2014¹⁸¹ and called “Singleton Property” caught my attention. This method is supposed to be leaner and more agile than reification, as it generates a considerably lower number of extra triples to achieve the same level of information. Moreover, as the authors stress, it relies on the formal RDF and RDFS vocabulary, enabling a valid formalisation of the information. The singleton property approach starts from the idea that every relationship is unique, as it connects two elements at a specific time, and according to a particular source, a premise that sounds rather relatable to the nature of the statements accepted in SCOTCH. From an RDF point of view, this approach suggests assigning an ID to each instance of a property (instead of to each statement), and then to attach information to it, instead of making the statement a new entity.

To give an example from the present triplestore, to state that the feature MANN1.1 used to belong to SpX_CoY, and that its source is an article by Sampaolo published in 1992, traditional reification would have required the following steps:

assigning an id to the statement and calling it, for example, statement#1. Then stating that:

statement#1 is a statement (rdf:type statement)
that MANN1.1 is the subject of such statement (rdf:subject)
that wasFeatureOf is the predicate of it (rdf:predicate)
that SpX_CoY is the object (rdf:object)
that statement#1 has source in the article by Sampaolo (scotch:hasReferenceIn)

The singleton property approach, on the other hand, suggests looking at the relationship between the feature and the constraint as something unique. So, for example, the instance of scotch:wasFeatureOf that links, specifically, MANN1.1 and SpX_CoY is called scotch:wasFeatureOf#1. To that property, which only occurs between those specific entities, provenance information can then be attached.

¹⁸⁰ Cf., for example, the controversy about the north and south wall in the ekklesiasterion, discussed in chapter five.

¹⁸¹ Cf. <https://mor.nlm.nih.gov/pubs/pdf/2014-www-vn.pdf>

In this other scenario, an additional statement is needed:

that wasFeatureOf#1 is an instance of wasFeatureOf, and so inherits all its characteristics (wasFeatureOf#1 is singletonPropertyOf wasFeatureOf). Then, it is possible to attach to wasFeatureOf#1 all the metadata, such as its provenance (the article by Sampaolo 1992). It is easy to see that this method, no less acceptable than traditional reification, generates fewer additional triples. Moreover, it seems to facilitate the process of data entry in a more elegant and less time-consuming way.

However, this solution to the creation of meta-statements is not structural to SCOTCH. It has been adopted for this proof of concept, as it is believed to be a functional approach in the present context. Nonetheless, deciding to follow traditional reification, or finding new, and possibly even better approaches to it, would not affect the structure, the rationale or even the vocabulary of this ontology.

4.8. Conclusions

This chapter described in detail the fundamental classes and properties that compose the SCOTCH ontology, and gives examples of their application in the documentation of the two 3D models of the Iseum in this proof of concept. Particular attention has been given to the modelling, in ontological terms, of the provenance of the various sources that informed the 3D visualisation, and how their different nature required different approaches in the documentation. It has been stressed that the aim of this documentation framework is not to quantify and assess the degree of “certainty” of the sources used as references, but simply to attest their role and to trace and record the workflow of the 3D authors. SCOTCH has also been presented as a strategy to enable citation and re-use within 3D visualisation, bringing the latter closer to canonical academic publications.

5. Between evidence and fabrication: the representations of the Iseum in images and words, and their role into SCOTCH

This last chapter will describe in more detail the sources, both visual and textual, that have been selected and analysed for this proof of concept. The specific nature of early depictions of Pompeii, and especially of the temple of Isis, will be highlighted and connected to the theoretical discourse around representations of ancient cultural heritage, but also to the use of Linked Open Data to describe and classify such sources. The peculiar nature of historical documents about the city of Pompeii will be used as an example of how the available data contributes to shaping the ontology and how it posed specific challenges; for example, in relation to the identification and modelling of authorship and the weight of artistic and cultural influences.

5.1. Modelling on site and off site features in SCOTCH

This proof of concept demonstrates the application of LOD to describe the relationships between the different spatial elements of a building, between those elements and their 3D representations and between the 3D representations and the sources that have informed their modelling. Lastly, the SCOTCH framework allows researchers to establish and show the connections between an ancient monument and its decorative features, including those that are lost, or have been moved and are now exhibited somewhere else.

From this perspective, another function that SCOTCH performs besides documentation is to act as an information-based digital unification, providing context to both the architectural component and the artefacts. Traditional 3D digital unification projects, like the work exhibited in the MAV in Herculaneum, involve a visual component and aim at showing the interaction between the objects and between the objects and the environment. However, establishing a relationship between a building, or one of its parts, and one or more artefacts already offers critical insights to either or both, and contribute to their fuller understanding. Looking at the wall frescoes found in the area of the Iseum, it is rather easy to identify some major differences and divide them into macro-groups: there are some very refined frescos featuring large panels depicting mythological scenes and intricate illusional architecture; some medium quality frescoes, with smaller panels, mostly still lifes, included into a larger, repetitive decorative pattern, and some rougher paintings on a solid colour background. It is not surprising, then, to verify that the differences in style and quality can be associated with their different locations:

respectively the ekklesiasterion, the portico and the area known as sacrarium.

The different quality of the decoration helps in making more reliable hypotheses about the use of the space. Likewise, the spatial context sheds light on some stylistic aspects of the decoration. Even in the absence of a full 3D visualisation that brings together the architecture and the frescoes, the information about their relationship supports and enhances their study. If the provenance of the artefacts found in the Iseum does not offer too many surprises, other examples may help to highlight the potential of the unification function enabled by SCOTCH. The plaster cast of a dog (Ill. 58), formerly exhibited in the small Antiquarium within the archaeological site of Pompeii,¹⁸² was one of the most popular Pompeian artefacts (Garcia y Garcia 2006). It is mentioned as a “must-see” in many tourist guidebooks and has been featured frequently in photographs, postcards and illustrations (Mackenzie 1910:172, Engelmann 1904:5, Scotti 1907:37). The unlucky animal was found in the so called House of Orpheus,¹⁸³ and it shares its provenance with another quite popular artefact, the mosaic of a dog (Ill. 57). The latter seems to conform to the style of similar mosaics in other houses in Pompeii and Herculaneum, usually interpreted as “beware of the dog” signs. The association between the two artefacts was picked up in some touristic guides, and exploited to solicit an emotional reaction in the visitors. The dead dog was the same dog for which the “beware of the dog” sign had been created and posed. This successful association was sometimes pushed to the point of creating an idealised fictional dog character that chose to die with its owners instead of trying to save his life:

Qui [...] fu trovato lo scheletro di un cane col suo collare, che fedele al suo padrone restò vittima della catastrofe. (Pagano 1877:87)¹⁸⁴

The story, although appealing to the public, also completely ignored the archaeological evidence, which in fact revealed that the animal was left chained to the house when the inhabitants fled, and died desperately trying to free itself.

¹⁸² The Antiquarium was closed after the bombing of Pompeii during the Second World War. The plaster cast of the dog is currently on display at the Antiquarium in Boscoreale.

¹⁸³ Formerly, House of Vesonius Primus.

¹⁸⁴ Here was found the skeleton of a dog, with its collar, who was so loyal to its master that become a victim of the tragedy.

Assigning URIs to smaller parts of a building, SCOTCH allows more granular association and shows, for example, that, according to Della Corte (1965:97), the popular “beware of the dog” mosaic, was not found at the fauces of the building, where typically such artefacts are found, in order to be easily seen by visitors and passers by. Surprisingly, the squared mosaic was originally placed inside a small cubiculum, and definitely not visible from the street. This unexpected location forces us, in a way, to reconsider the artefact and make new, different hypotheses about its use and purpose (Ill. 60).

As already pointed out, even without a full 3D visualisation of the architectural context and the original placement of the artefacts, the information about spatial relationships provided by SCOTCH helps us to look at historical artefacts in a more comprehensive way and, possibly, suggests new and different questions about them.

Thanks to the increasing number of archaeological museums making available data about their collections (including images, and 3D meshes¹⁸⁵), linking the information about the artefacts in LOD with the architectural context through the 3D visualisation and its documentation becomes relatively easy, and yet also powerful. The simplicity of the properties `scotch:hasFeature` and `scotch:hadFeature` (and their inverse `scotch:isFeatureOf` and `scotch:wasFeatureOf`) have been used in this proof of concept to model, at least partially, such information, with special attention to the collection of artefacts found in the Iseum that are now exhibited in the Museo Archeologico Nazionale di Napoli (MANN). The MANN's cataloguing system¹⁸⁶ has been used as a reference for the naming of the artefacts in the triplestore.

The features that still belong to the material space have been documented according to the SCaT convention, as explained in chapter three. But the information about a feature that is not in situ anymore, and its (possible) former relationship with a spatial element (via the property `scotch:wasFeatureOf`), needs to be modelled differently. The statements about the feature that is now lost, destroyed or moved have to point at a document of various kinds, including visual documentation, archaeological reports, and previous scholarship, using the SCOTCH property that is appropriate for the nature of the source (for example `scotch:hasEvidence`, `scotch:hasReferenceIn`, `scotch:isBasedOn`). As discussed in chapter four,

¹⁸⁵ Cf. for example, the online galleries of the Victoria and Albert museum, or the 3D galleries of the Petrie Museum.

¹⁸⁶ As it appears on the labels of the artefacts in the rooms dedicated to the Iseum in the Museum. A different, more specialistic convention, seems to be applied to those objects that are not on display.

the statements about former features of the represented space needed a process of reification in order to be modelled.

Looking at the artefacts found in the Iseum, for example, the west wall of the ekklesiasterion (SpE_CoW) used to host a large fresco (Ill. 44): *Sacred fence with temples, statues, and square with trees, seen through an architectural scene*. The fresco is now in the MANN's collection. Its catalogue number has been used in SCOTCH as an identifier to establish a unique and unambiguous connection (MANN1.66). An online digital image of the fresco¹⁸⁷ has been linked via the property scotch:facSimile. A relationship between the wall and its painted feature has been established in the documentation: SpE_CoW scotch:hadFeature MANN1.66. The work of Sampaolo 1992 has been given as the source for such an association. Potentially, more information about the artefact could be added, following, for example, the Getty AAT vocabulary, to describe further details such as materials or techniques. However, this was not considered a priority in this research.

Connecting the features with their representations and also pointing at their records as objects in museums or archives improves the value of the documentation and offers, in some cases, the opportunity to compare the representations, either visual or verbal, with photographic records of the artefact. Such comparison strengthens the documentation and, once again, acts as a reminder of the representative and subjective (and therefore fallible) value of the depictions of ancient objects. This seems even more useful when dealing with the documentation of an old, and often confusedly recorded archaeological site, such as Pompeii.

Looking again at the case of the frescoes in the ekklesiasterion and their documentation, the drawings by Morghen and Chiantarelli are certainly inconsistent with the surviving frescoes and the museum records. Both Elia (1941) and Sampaolo (1992), claim that the official documentation produced at the time of the excavations does not possibly match the actual fragments held in the museum, and have suggested different hypotheses for the original arrangements of the frescos that used to decorate the ekklesiasterion. Both scholars agree that fragment 1.62, *Landscape with ceremony in honor of Osiris* (Ill. 46) should be placed in the left side of the south wall (as the *Pompeianarum antiquitatum historia* records) and not at the right side of the west wall as the engravings show (Ill. 21). They supported this assumption mainly

¹⁸⁷ A photograph of the original fresco that has been updated on Flickr at <https://www.flickr.com/photos/134064462@N06/29205867655/in/album-72157675800187860/>

with the presence of a framing column on the right edge of the fragment, that would not perform any meaningful function if the framed scene was already positioned on right of the whole composition. Moreover, if fragment 1.62 were on the right side of the west wall, it would be asymmetrical with fragment 1.66, (Ill. 44), that all sources agree was located on the left side of the west wall. Such a hypothesis would contradict the decoration patterns of the remaining areas of the Iseum, as well as our general assumptions about Roman frescoes. In addition, Elia suggested that the right side of the west wall was actually occupied by fragment 1.67, *Landscape with sacred door and velum* (Ill. 45). The *Landscape with sacred door and velum* does not even appear in the engravings but the piece had been explicitly recorded as “from the Temple of Isis” when it was catalogued (Sampaolo 1992). Homogeneity of style, colour and dimensions support this theory and fragment 1.67 is officially exhibited in the museum as part of the ekklesiasterion in the museum collection. Elia’s convincing theory, unanimously accepted by archaeologists and museum professionals, also implies that the scene that Chiantarelli drew on the right panel of the west wall of the ekklesiasterion in place of fragment 1.62 is entirely fabricated (in spite of being part of the official documentation commissioned during the excavations).

Although fully recognising the flaws of the historical documentation of the ekklesiasterion, in the IseumGT model I have used those drawings as textures nonetheless, as my purpose was not to visualise the original position of the frescos’ fragments, but to show how the space of the Iseum was represented, communicated and perceived in the years of the Grand Tour.

The information about the original position of the frescoes is part of the documentation, but is linked to the related spatial element and not to any of the specific 3D visualisation here presented.

Elia and Sampaolo agree in every respect aside from the positioning of two of the large frescoes that were supposed to be on the north and south walls of the ekklesiasterion (SpaceE) and are now in MANN: *Io in Canopo* (MANN1.63) and *Io, Argo and Hermes* (MANN1.69). As I have already reported in Vitale 2012, according to Elia, the original position of fragments 1.63 and 1.69 is inverse to the one documented by Chiantarelli and Morghen. Elia hypothesised that the frescoes were likely intended to be exposed following a narrative order proceeding from left to right. Therefore, the episode that happens chronologically first in the myth of Io should be located on the left (SpE_CoS).

However, Sampaolo (1992) underlines that there is no actual evidence for such practice in Roman painting. Besides finding Sampaolo's argument more convincing, the walls of the Iseum in IseumGT have all been textured according to the eighteenth and nineteenth century documentation, regardless of its reliability. However, to enhance the transparency of the documentation and its multivocality, the existence of another, dissonant resource has been recorded through the property `scotch:isNotSupportedBy`, pointing at Elia's theory in its published form. Consistently with SCOTCH's general approach, if the statement that a feature used to belong to a certain spatial element cannot be documented in any existing published reference, then the 3D creator has to be recorded as the source of such information.

Although this proof of concept does not explore this opportunity, the SCOTCH structure would easily allow one to add even more precise information about the location of present and former features, introducing properties such as `scotch:hasPosition` or `scotch:hadPosition`. Thanks to these two properties, the relationship between a feature and, for example, a space, would be more precise, and refer to particular corner or even coordinates. The provenance of the information about position should be documented following the same standard described above. Information about position of features could have been, for example, applied to enrich the LOD documentation about the several statues found in the Iseum.

5.2 A SCOTCH classification for visual and textual secondary sources

5.2.1. Records, Restorations, and Impressions: three subtypes of visual documents

A small selection from the vast number of depictions of Pompeii produced in the last two and a half centuries has been chosen for inclusion in this proof of concept. A copy of the illustrations included in the documentation is available as an appendix (Appendix B) to this thesis.

In the first place, the images have been connected, via RDF triples, to the spatial elements they represent. However, listing every single spatial element that appears in any of the selected visualisations was not a priority in this research. In the proof of concept, only the main elements that are visible in the images have been recorded in LOD. Therefore, the description of what can be seen in the visual documents is by no means exhaustive. The purpose of

identifying the spatial elements of the Iseum that are depicted in those images is not to describe the original sources in their completeness. If the images were indexed in detail, and the information modelled in RDF, it would facilitate the work of future virtual and traditional archaeologists, making the search for visual sources much more precise and efficient. However, enhancing metadata about historical depictions of the Iseum was not the main purpose of this research. Therefore, in the triplestore here presented, the connections between images and depicted elements tend to be partial and driven by the documentation of the 3D representations. In this sense, the images are always related to the 3D element for which they have been a source or guideline, but not necessarily to all the others depicted. Unlike 3D files, images benefit from a longer and more established culture of cataloguing. It seemed a reasonable choice, thus, to use the framework of the Dublin Core standard for this purpose, including the property `dc:depicts` in SCOTCH. Information about images that have been inputted in the triplestore include: author, date of publications, bibliographic citation, all modelled according the Dublin Core popular and highly interoperable ontology.

This research strongly argues for the subjectivity of photographs and their nature as representations instead of “copies of reality”. However, photographs can be, and often are, considered more reliable descriptions of a material referent than drawn illustrations. To capture these differences, the class `scotch:images`, that includes all the visual representations used as sources, has been divided into two sub-categories: `scotch:photographs` and `scotch:illustrations`. This differentiation is not only for cataloguing purposes. From an ontological perspective, photographs are permitted as evidence of both the existence of a spatial element, or the dimensions of an element, if a scale has been photographed along the object.¹⁸⁸ The class of photographs also includes a small number of videos shot onsite. However, the creation of a dedicated category is another suitable option.

It is important to highlight that the two categories just introduced, photographs and illustrations, as well as the categories that will be presented in the following paragraphs to classify visual and written records, are not meant to mirror, or to be mapped against, the `scotch:hasSourceType` categories. The former pertain the representations, in words and images, of the referent (in this case, the Iseum in Pompeii) and group such representations

¹⁸⁸ Cf., for example, the picture <https://www.flickr.com/photos/134064462@N06/19720427606/in/album-72157655540228150/>

according to some of their qualities, for example being produced via a camera or illustration tools, including CAD software. The second pertain one specific 3D representations of the material referent, and record the role that each resource, published or unpublished, has had on the choices of the 3D author during the modelling process. An impression of the temple of Isis painted by Bazzani (Ill. 27) in one of his watercolours could be used, for example, as a reference for the 3D visualisation of space of a spatial element. In this case, the 3D file will have a `scotch:hasSourceType` `scotch:secondary`. But a virtual restoration with an embedded scale, such the one published by Piranesi (Ill. 1), can, and has been in this proof of concept, considered as academic research, therefore labelled as `scotch:guessed`, based on scholarship. Not all the visual resources that have been linked to the spatial elements of the Iseum have been also used as sources during the modelling of the two 3D visualisations Iseum79 and IseumGT. The aim of this classification is not to extend the documentation process to the secondary sources, trying to decide on what kind of information the artists, historical or contemporaries, based their own choices. Such process would not only be hardly feasible but would also contradict one of the main assumption of SCOTCH, which is that each author is responsible for the documentation of its own representations, and its original scope that is documentation of 3D visualisations. These classes are simply introduced to enrich the information about the different representations of the referent, and their relationships.

Drawings, paintings, engravings and all the other representations grouped under the label `scotch:illustrations`, are not considered evidence in the SCOTCH ontology but only references. There are many extraordinary examples of faithful and precise drawings of ancient heritage sites, but there are even more examples of flawed, incorrect, sometimes explicitly misleading ones. The unreliability of colour information has already been mentioned in the second chapter, as well as the practice of editing the appearance of the actual landscape to make it look more aesthetically appealing, or just clearer in the eyes of the audience. It is not uncommon that the representations of the Iseum show, to different degrees, manipulation of the actual landscape. In the popular engraving by Piranesi the Younger (Ill. 35), both the east side of the colonnade and the east wall of the portico have been deleted from the picture. It is probable that the subtraction of those elements was intended to show off more easily the main buildings of the Iseum. The removal of a major architectural element, also found in Piranesi the Elder (Ill. 36) and Wilkins (Ill. 32 and 33), almost turns the image into a theatrical set, where the fourth wall of

a room has been taken out to let the audience follow what is happening inside. The practice, maybe very common and immediately recognisable at the time, might be quite misleading for of a modern viewer, especially in the case of someone trying to research the former look of an ancient building through the study of secondary sources. A striking example is offered by the unidentified artist of the *Voyage pittoresque* (Ill. 34). As the other images mentioned in this paragraph, the east wall is missing. Moreover the columns at the north-east corner have all been artificially severed, again, probably in order to facilitate the view. However the illustration, that appears in a guidebook of Pompeii, is accompanied by the caption “Désigne par nature”, feeding the misleading impression that the depiction is actually accurate. Likewise, in Cooke’s illustration for *Pompeiana* (Ill. 30) an artificial break has been introduced in the east wall of the portico, probably in the attempt of showing as much as possible of the ancient buildings in one single panorama. The solid and quite tall wall of the Iseum would, in fact, have covered part of the view, and definitely most of the buildings inside the Iseum itself. In this illustration, the wall is depicted with quite dramatic damage, which never existed, that is even more misleading as the scene is drawn in a very realistic style.

An analysis of Pompeian secondary sources highlights their peculiar nature; an undividable blend of very accurate, precise information and entirely fictional modifications and additions. For this reason, it is generally very difficult to consider illustrations as evidence. The same drawing, in fact, can be a very reliable source for some spatial elements and a misleading one for others. For example, in spite of its licence with the eastern side of the colonnade and portico, Desprez’ drawing of the Iseum is an exceptionally detailed documentation of the stucco decorations of both the main temple and the purgatorium. To enrich and clarify the metadata about depictions of the Iseum, three different subcategories of scotch:illustrations have been introduced. The first one is “restorations”. Although the name is old-fashioned and frowned upon by scholars in 3D visualisation, it still clearly defines a class of objects: images that show the former, original look of an historical place or object. CAD 3D restorative visualisations belong to this category. But also restorative architectural elevations and cross sections such as the one by Piranesi (Ill. 1, Ill. 4), or scenes recreating “everyday life” such as the reconstructed Isiac ceremonies depicted by Desprez (Ill. 3) or Leroux (Ill. 7).

Hypothetical reconstructions are by no means a new trend, and actually many of the issues about transparency that are met in 3D visualisations have been inherited from traditional illustrations (James 1997). If the presence of reconstructed elements seems relatively easy to identify, less straightforwardly recognisable might be the difference between the other two categories: “records” and “impressions”. The rationale behind their creation was to make a distinction between those drawings that have been produced for scholarly purpose, such as architectural plans, illustrations for historical publications, and images that were meant to be mere artistic impressions of a place or a monument. The expectation would be that images produced for a recording purposes would be more reliable, while images that are produced for aesthetic purposes are more likely to show personal re-interpretations of the depicted material objects. In this sense artistic impressions would be a less reliable source in the investigation of the former appearance of an historical place, but a perfectly valuable material in the study of the reception of the same place.

This simplistic expectation is sometimes subverted when looking at actual data. What are supposed to be faithful records, such as the documentation of the *ekklesiasterion* by Chiantarelli and Cattaneo (Ill. 21), features fabricated elements that are even more difficult to identify due to the realistic style of the representation and its official purpose. On the contrary, some artistic impressions demonstrate a remarkable fidelity to the original object, as it is exemplified by the work of Italian painter Luigi Bazzani (Ill. 27), whose watercolours are now considered a precious source of information for the original look of Pompeian places and artefacts. Bazzani’s work has been used as a reference in a digital project, matching his paintings with the actual places in Pompeii and pointing out their astonishing affinity.¹⁸⁹

Not only are the expectations of reliability sometimes reversed, but it is also not always easy to assign an image to one category or another. Considering that it may be problematic to trace a line between the two sub-types, a single criterion has been identified in order to make the separation simpler, if not always perfect. As it is impossible to say what was the purpose of the artist at the moment of the creation of the drawing, I have decided to rely on a tangible mark like the presence of an embedded scale in the illustration. It seems safe to assume that the presence of such a visual device states a sort of documentary purpose for the image created.

¹⁸⁹ <http://www.cineca.it/it/news/pompei-vista-da-google-earth-negli-acquerelli-di-bazzani>. Bazzani also had an entire exhibition dedicated to him and his work held in the museum of Naples in 2015.

This criterion is by no means a way to unambiguously detect the purpose of a representation. For example, the only detail that separates the cross-section drawn by Durban (Ill. 26) from similar works by Hardwick (Ill. 14), Mazois (Ill. 13) or La Vega (Ill. 10) is exactly the absence of a scale. Nonetheless, this seemed to be a reasonable choice for defining the two categories of images.

As already discussed in the previous chapters, due to the peculiar history of the site visual records of Pompeii highlight how complex the relationship between an object and its representations can be. Some of the depictions of Pompeii, including the new digital three-dimensional ones, can be incomplete, incorrect or distorted, both entirely or in part. A very popular digital reconstruction of the Iseum quite blatantly inverts left and right in the landscape, positioning the theatre on the wrong side of the view¹⁹⁰. In John Soane's watercolours, the scales and the drawings do not seem to match. It would be interesting to model this kind of information through RDF during the process of documentation. To identify, for example, all the elements depicted and how many of those are realistically represented, versus how many are distorted or even fictional. However, such an endeavour requires both the development of a specific ontological vocabulary, to deal with the many possible intermediate stages between realistic and completely fabricated representations, and a thorough study of each single image. Neither of these two tasks were among the aims of this research, although they are perfectly compatible with the proposed documentation framework, and could be subsequently developed.

5.2.2. Classification of written sources

The issue of reliability, and the difficulty of separating accurate bits of information from what is purposefully or accidentally erroneous, does not pertain to only images. Likewise, texts can be composed for different purposes and blend different kinds of information. The city of Pompeii used to be cited many times in popular fiction, and became almost a fashionable literary trend, as the works by De Staël, Gautier, Jensen, Leopardi, Nerval and many others show. Looking at the stories inspired by the "buried city", it seems, generally speaking, that the authors were looking rather for an atmospheric setting than archaeological accuracy, although sometimes relevant information might still be found. However, Bulwer-Lytton, and many of his

¹⁹⁰ See: <http://www.the-romans.eu/Museum/var/albums/Museumpieces/British-Museum-London/bml234-isis-temple-pompei-drawing.jpg>

readers, considered the descriptions of Pompeian artefacts (and their use) featured in *The Last Days of Pompeii* accurate and archaeologically grounded - a statement not likely shared by many modern archaeologists or classicists.

As for images, it is often really challenging, if not impossible, to clearly define the nature of a written source, especially considering the peculiar context of Pompeii and its history as a site. What are supposed to be official excavation reports are actually riddled with fabrication, lacunae and the average amount of human error (Jacobelli 2008). The supposedly subjective, and sometimes even strongly biased sources of information such as private letters or diaries, have sometimes proved to be the best opportunity to gain an understanding of what was going on in Pompeii and Herculaneum in the early years of the excavations, as shown, for example, by Winkelmann's epistolary. Archaeological guides, then and now, are divided into good and well documented publications, and more anecdotal ones that prefer a narrative (and not evidence-based) approach to a more fact based description.¹⁹¹ It was part of this research to extrapolate visual information from textual sources, as sometimes they have proven to be able to give insights on both the look of the material objects and their interpretations. Textual documents have been linked via RDF to the spatial elements, usually at the level of spaces. As for images, though, a difference has been established to divide the sources into two main categories: those explicitly published as a means of information and those that have a more entertaining purpose. Two specific properties have been introduced in SCOTCH to model the relationship with textual sources: `scotch:isMentionedIn` and `scotch:isDescribedIn` (their inverse properties being, respectively: `scotch:mentions` and `scotch:describes`). The former connects a spatial element to a fictional or, generally speaking, not official text that says something about it. The latter is reserved for a quite narrow subsections of documents that are official reports and scholarly publications.

As the main focus of this research was on visual representations, the approach to texts remained rather simplistic. Various kinds of text are situated in between these two broad categories but have been allocated into one or the other. Other texts might not really belong to either.¹⁹² Each textual resource has been entered as individual in the triplestore, with all the

¹⁹¹ The author does not intend to suggest in any way that narrative approaches are, per se, unreliable, although they are inherently more delicate to handle. The paragraph refers to those specific archaeological guides that have an anecdotal approach and are also unreliable.

¹⁹² Such as, for example, exhibitions catalogues.

related information attached as RDF, in the Dublin Core standard vocabulary. It would have been easier to establish relationships between the spatial elements and the text as a whole. However, a more granular approach has been preferred. Therefore, each single citation (including those that come from the same publication) has received a different URI, and has been treated separately. The full bibliographical reference, in its classic form, is given via the `dc:bibliCitation` property, along with the name of the author and date of publication.

5.3 Availability and selection of sources: abundance and inconsistency of analogue and digital documents on Pompeii

The ancient city of Pompeii is, at the same time one of the best and worst scenarios for a 3D visualisation with an open documentation that links, whenever possible, to resources available online. The astonishing amount of historical information, coupled with the emotional charge of a place hit by a sudden tragedy, has brought a substantial number of academics and artists to Pompeii in the past two hundred and fifty years and solicited the production of a large number of studies, records and copies. The popularity of the buried city has also encouraged, in most recent times, a larger than average number of digitisation projects around maps, copies, art, photographs and documents related to Pompeian buildings and artefacts. A large amount of those resources are now free from copyright and available on online repositories so that they can be easily included in a LOD documentation.

If the number of the available digital resources is encouraging, their quality is uneven and, sometimes, disappointing. Looking in particular at visual representations, the range goes from digital documents in good resolution, accompanied by exhaustive metadata and semantic correlations expressed hypertextually offered by projects such as *La Fortuna Visiva di Pompei*,¹⁹³ to illustrations found in digitised online books (for example in archive.org or even Google Books). In the latter case, the available metadata more often refer only to the main publication, and do not describe the single images in details, sometimes omitting even basic information such as author and title of the illustration. Moreover, the captions of the illustrations are often digitised in image format and, as such, they often fail to be included into text searches. This makes it particularly hard to discover whether a digitised book contains an image of a specific Pompeian building without looking at all of them. In digitised books the quality of the

¹⁹³ <http://pompei.sns.it/>

images, also, tends to be rather poor. Although relevant as part of documentation for a 3D visualisation, these kind of sources could be hardly used as modelling guidelines and, even less, as textures.

As introduced in the previous chapter, it is not uncommon to find digital reproductions of depictions of Pompeii as part of large digitisation projects that involve major libraries and archives.¹⁹⁴ The data is then usually uploaded to academic repositories or free-to-access platform such as Flickr. On the one hand, the amount of visual representations of Pompeii that are available online in various formats keeps growing, making the search for online material richer everyday. On the other, the quality of both the digital images and their metadata is still somehow unpredictable. Unfortunately, a systematic work of identification and indexing of the represented buildings seems to be missing, and, most of the times, the images are just generically labelled as “Pompeii”.¹⁹⁵

The fragmentation, inconsistency, unreliability and partial redundancy of digital sources mirrors and emphasises the nature of the original historical sources. The peculiarities of the archaeological sites of Pompeii and Herculaneum, and the specific cultural and historical context in which the first excavations campaigns took place have several repercussions for the visual material produced about Pompeii. Those influences are multiple, complex, and, often intertwined. An understanding of the unique situation in Pompeii and Herculaneum is definitely crucial in the analysis of the secondary sources, and in the understanding of the specific challenges that they posed during the design of the ontology.

5.3.1 Authorship and genealogy of the sources

One first issue around early Pompeian illustrations was assigning authorship correctly. Especially in the case of images published to accompany text in books or in the case of engravings, information about authorship becomes confused and insufficient. In various repositories, for example, the name of the draughtsman and the name of the etcher are randomly used as generic indication for “author”, without any reference to their role in the

¹⁹⁴ Cf., for example, the depictions of Pompeian buildings that appear both in the Flickr account of the Internet Archive and of the British Library.
<https://www.flickr.com/photos/internetarchivebookimages/>
<https://www.flickr.com/photos/britishlibrary/>

¹⁹⁵ Surprisingly, the many works by Gian Battista Piranesi that are archived in the Wikiart project, are even wrongly labelled as “Rome”.

production of the image or the existence of other collaborators. A good example is the case of Giovan Battista and Francesco Piranesi. The same works are attributed, in different metadata, to either the son of the father only. In only a few cases does the metadata state more clearly that Giovan Battista is the author of the drawings, while Francesco the etcher, although as Giovan Battista was dead when the *Antiquites* was published, Francesco's name appears on the cover as the only author. A very thorough model for authorship attribution of visual sources is offered by the digital project *La Fortuna Visiva di Pompei* (LFVP). The metadata of their archive not only identifies and distinguishes drawers and etchers, but sometimes even point out less traceable intellectual and artistic contributions, introducing credits for the “inventore” of the illustration. The metadata model presented in LFVP reaches a very satisfactory level of detail. However, it seemed not necessary, in the context of the present proof of concept, to express information about the sources to this level of granularity. Not wanting to suppress the information either, I have reached a middle ground, entering the information about the authors as free text and using it as value for the property `dc:creator`. In the case of the etching by Piranesi father and son published in the *Antiquites*, the image is documented via the property `dc:creator` with value “Piranesi, G. B. (illustrator) & Piranesi, F. (etcher)”.

As already discussed in the second chapter, obtaining permission to copy Vesuvian artefacts in the early years, from either the excavations sites or the museum in Portici, was not just a formality or a matter of bribery. The royal family was extremely proud, and indeed possessive, of their collection, and were committed to maintaining full control of the published material about those artefacts and monuments, in part through the creation, in 1755, of the *Accademia Ercolanense*.¹⁹⁶ According to the account of Anna Miller, a visitor of the museum in 1776, even the prohibition of touching the antiquities on display did not come from an understandable concern about the conservation of such fragile and valuable finds, but was regarded almost as the “theft” of small particles of property belonging to the Royal Family:

I wished to have been permitted to rub my finger (as a little remained on it) upn a piece of paper, just to bring with me an idea of the colour; but besides a sharp, though civil reprimand, for my curiosity, he [the guard] insisted peremptorily on my not carrying off an atom; ‘for,’ said he, ‘it is a curiosity no monarch upon earth can boast the

¹⁹⁶ See further: Castaldo 1840.

possession of, besides my master, the King of Naples.” (Miller 1776:263-264. Cited in Moormann 2015:31)

Meanwhile, requests for more information and more images from Pompeii and Herculaneum, both within and outside of academia, were growing in Europe, and becoming a much larger market than the controlled and verified publications by the Accademia Ercolanense could satisfy. Pompeii and Herculaneum became unmissable stops in the *Grand Tour* and unauthorised publications started to appear, especially in European countries other than the Kingdom of Naples. As Leppmann relates, Winkelmann’s unauthorised notes on Pompeii and Herculaneum were quickly translated into French and published. Although the Royal Family in Naples definitely did not appreciate the whole operation.

Among these contemporary reader [of Winkelmann] was the French archaeologist and art collector Anne-Claude-Philippe de Caylus, who promptly had the Report on the most recent excavations translated into French in order to give it wider publicity [...]. Bit when Abbé Galliani, secretary of His Sicilian Majesty’s ambassador in Paris, gave Sir William Hamilton a copy of the French text to take along to Naples, that Majesty and all his ministers were incensed at what they considered a grave indiscretion on the part of Winkelmann; the latter, in turn, became so apprehensive that he confessed to a friend his fear that ‘a beating, if not something worse’ would surely await him on his next trip south (1968:74-75)

If possible, this made control over the Pompeian antiquities and their reproduction even stricter than before, and the artists that applied for a permission were more often regarded as potential traitors, and “smugglers” of precious drawings than welcomed scholars. Being caught copying the antiquities or, even worse, being identified as the source of the leaked information, would result in a perennial ban from the site and, possibly, even legal charges.

Furthermore, the unstable political events that were happening all over Europe in the eighteenth century, and the spread of revolutionary cells are likely to have contributed to the creation of an atmosphere of diffuse diffidence in the Neapolitan monarchy. As a consequence, Charles and his descendants became extremely cautious in admitting foreign scholars and

artists to the excavation sites, and even more cautious in giving permission to reproduce antiquities.¹⁹⁷

Such strictness had a number of indirect effects on the way Pompeian monuments were represented. Not only did it lead the artists to develop the most bizarre techniques for coping the paintings and other artefacts in a more or less subtle way, but it also made relatively popular the more affordable practice of simply copying and reprinting, probably without any kind of authorisation or acknowledgment, the few published images available. Going to Pompeii was expensive, in the first place, but it was also often just not possible. Copying previous representations instead of the original object, was definitely a more economical and faster, although not entirely legal, option that would have allowed publishing houses to satisfy more easily the growing demand for information about the fascinating, and fashionable, discovery.

5.3.2 Modelling copies and copies of copies: the multiplication of errors in Pompeian records

The fact that, on occasion, the images depicting Pompeian monuments did not originate through the original artefact, but rather copying (sometimes clumsily) previously published visual material seemed something worthy of inclusion in an ontology with the purpose of documentation. Before minting new classes or properties in SCOTCH, I searched for other ontologies that might have modelled, at least partially, similar issues and could therefore be included in my documentation framework. I looked at the properties in the CiTO ontology, as they specifically focus on the provenance of documents and their possible relationship, including quotations, references and re-use. However, the CiTO ontology seems to be mostly developed having textual resources in mind, and did not offer a model for all the scenarios I wanted to describe. The only property that I decided to borrow from the CiTO ontology was `cito:plagiarizes`. Although the concept of “plagiarism” is relatively modern, and not always appropriate in the discourse around works of art produced two centuries ago, this property indicates “[...] that the author of the citing entity plagiarizes the cited entity, by including textual or other elements from the cited entity without formal acknowledgement of their source. The citing entity thus contains no explicit citation of the cited entity, according to the norms of

¹⁹⁷ Although, apparently, they were not cautious enough as Francesco Piranesi, the son of Gian Battista, turned out to be part of a Swedish rebellious cell (Harris 2007).

scholarly practice, but cites it implicitly”, regardless of the acceptability of such practice in the past.¹⁹⁸

After a continued analysis of secondary sources depicting the Temple of Isis and the Iseum, it becomes easier to identify similarities between images and to make hypotheses about their relationship. However, the process of creation and its chronology is often hard to rebuild, considering that the publications were sometimes illegitimate, and that the artists did not always want to have their name associated to them, and were even less inclined to declare their intellectual debt to other artists. Stating that an image is the undeclared copy of another one, can be sometimes very apparent to a trained eye, but remains a subjective scholarly assessment, and it needs to be defined as such in the ontological model. Therefore, the property `cito:plagiarizes` is used, within SCOTCH, in a reification context. As explained in chapter three, each statement about plagiarism will receive a URI, and information about authorship and time will be attached to it. Moreover, in the SCOTCH documentation framework, the property `cito:plagiarizes` is only used when a proof can be cited to support such a statement, for example letters, diaries, personal annotations or contracts. When it is not possible to formally prove the plagiarism, a more generic property has been preferred, to simply express the existence of a relationship between the two visualisations: `scotch:isRelatedTo`. The use of the property `plagiarizes`, borrowed from the CiTO ontology, has been theoretically described in this chapter, but has no applications in the documentation of this proof of concept, as none of the selected sources met the requirements.

When analysing two similar illustration of the same place, it is not always simple to establish which image is the copy of the other. In addition, the “genealogical” relationship between two related images is not necessarily between the original one and its copy, but could easily be between two copies of the same original, or even between a copy and a copy of a copy. Subtypes of the fairly generic `scotch:isRelatedTo` might be developed by art historians, or other researchers more interested in mapping the nuances of influences in visual outputs.

A different modelling approach was applied to those documents that explicitly declare the influence of previous works. These kinds of illustrations are likely to belong to the tradition of *studi* and other learning techniques that involve practising and perfecting skills by copying existing work of arts. In the selection of sources presented with this proof of concept, an

¹⁹⁸ See further the CiTO ontology at <http://www.sparontologies.net/ontologies/cito/source.html>

example can be found in the drawing of the Iseum by Joseph Woods (Ill. 31). The watercolour of the elevation of the Purgatorium shows an annotation saying 'principally from RHS'. The words have been interpreted, by the curators of the Royal Institute of British Architects (RIBA) archive, as a note explaining that the drawing is not based on direct observation but on a previous drawing made by another artist: Wood's colleague and Grand Tour companion, Richard Hey Sharp.¹⁹⁹ Sharp is, consequently, also indicated as one of the authors of the drawing in the archive, although the material executor is Woods solely. CiTO does not seem to have a property fit to describe the act of copying an image for the purpose of study. Therefore, the property `scotch:isCopyOf` has been minted to model it. It was not possible to find the original drawing by Sharp that was the inspiration for Wood's copy. Therefore, Wood's watercolour portraying the Purgatorium is documented as `scotch:isCopyOf` an original by Sharp, although no date or bibliographical information could be attached to the latter. As for `cito:plagiarizes`, `scotch:isCopyOf` needs to point at a document attesting the explicit relationship between the two images. In the case of Sharp and Wood, the transcription of Wood's handwritten notes published by the RIBA website.

The "journey" of a visual source through its declared or undeclared copies can be easier to follow and analyse when looking at mistakes and how they propagate. At the beginning of nineteenth century, Francesco Piranesi published a drawing in his²⁰⁰ monumental *Antiquités* captioned as *Niche dans le temple d'Isis, à Pompeia* (Ill. 37). The image, which looks detailed and realistic, does not represent any real space in the Iseum. The frescoes on the walls portray Egyptian deities, and it is possible that the niche depicted by the younger Piranesi was simply located in one of the many other buildings that, in those years, had a reference to Isis in their names and then wrongly grouped and published with the images from the Iseum. In 1827 a very similar drawing, again captioned as belonging to the Iseum, was published in *Pompeii, illustrated with picturesque views, engraved by W. B. Cooke, from the original drawings of lieut. col. Cockburn* (Ill. 38). No reference to Piranesi is made, although, as it is not actually a feature from the Iseum, it is very likely that Cockburn was familiar with Piranesi's work and took his inspiration from it, or from another declared or undeclared copy of it. As this plagiarism is impossible to prove, the property `scotch:isRelatedTo` has been used to link these two resources.

¹⁹⁹ Cf. <https://www.architecture.com/image-library/RIBApix/image-information/poster/temple-of-isis-pompeii/posterid/RIBA12470.html>

²⁰⁰ Mostly based on his recently passed away father's previous drawings.

scotch:isRelatedTo does not imply that the connection is strictly direct, but includes the possibility that a number of intermediate steps might have occurred. Some years later, at the beginning of Twentieth Century, Gusman, in his *Pompei, the City, Its Life & Art*, features again a drawing of the same niche, stating that it is located in the Iseum (Ill. 39). Gusman, however, does cite Cooke's book as his source for such information. The illustration in Gusman is, therefore, modelled as copy of that by Cockburn (scotch:isCopyOf). The document supporting the association is the caption accompanying the image in Gusman's book.

In both cases of plagiarism and copy for study, if the researcher is not the first person to establish such a relationship, bibliographical references could also be added through the scotch:isSupportedBy property. If there is a recorded disagreement about the suggested association, it will be modelled, as usual, with the scotch:isNotSupportedBy property. If the researcher is willing to give further information, an annotation might explain the reasons of the assessment. For example if the two visual representations share the same point of view, the same framing, or reproduce the same shadows. Formalising and modelling the information that is behind the assessment of similarity among images is a fascinating task that, however, falls outside the scope of this thesis and my personal expertise.

Identifying similarities in the published depictions of a place of cultural heritage might contribute to the tracing back of the history of a publication, and enhance the knowledge of an artefact *tout court*, highlighting and representing connections that were not immediately visible. For example, through such a documentation it would be easier to discover (or hypothesise) whether two artists had access to the same original, and then produced two different copies; or if a series of artists kept reproducing each other's work in a chain, adding more and more layers of personal interpretation and aesthetic choices, weakening progressively the informative relationship with the original artefact.

Addressing the existence of various copies of the same original image (or a series of copies of copies that is hard to track back accurately) also helps to assess the informative value of such resources. Secondary sources are often used in visualisations as clues to the former appearance of an artefact, especially when the artefact itself does not exist anymore. The presence of a detail in various, apparently independent, publications, may lead to a false idea of reliability, as if different witnesses were stating the same fact, corroborating each other. However, the detail might be just replicated uncritically by artists that have little or no direct

experience of the original artefact, hence reproducing not only the image but the errors in it. Undeclared copies, in particular, might originate a misleading sense of certainty that is based on mere quantity and not on quality. Furthermore, the inaccuracies of an image might have been replicated so often and disseminated in print, to the point that the representation may look more convincing than another that is more accurate, but which never achieved the same exposure.

Many of the issues encountered and discussed here regarding the visual records of the Iseum could apply to verbal documentation as well. Textual description of the Pompeian buildings were sometimes written relying on memory; they therefore slightly confused, or sometimes partly plagiarised from other published sources and some other times were heavily influenced by current literary trends and mainstream interpretations of the archaeology. Romantic French novelist and poet Gerard de Nerval, for example, starts his story - called *Isis* and set in Pompeii - with a description of the Temple and its surrounding space that is dramatically wrong. Scholarship traces this apparent mistake back to the influence of the German archaeologist Karl August Bottiger, who Nerval used as source and, apparently, trusted without any additional checks.

Looking at the description of spaces and buildings in the Iseum, the written sources here discussed show a surprising level of homogeneity. The same, almost identical, sentences are sometimes used to portray areas of the Iseum. It seemed reasonable to assume a certain amount of plagiarism, or simply editorial laziness. However, I did not include an analysis of the possible relationships among the different texts in this documentation, as this work was meant to be mainly visual. A reflection on this aspect would be an interesting addition to SCOTCH and would probably make the most of the conceptual overlap with the CiTO ontology.

Looking at the guidebooks also highlights some more subtle influences, not in the form but in the content of the text. A useful examples is given by the strong influence that the popularity of Bulwer-Litton novel *The Last Days of Pompeii* had on both the authors of the guidebooks and the public. In Litton's novel, the Temple of Isis was the headquarter of the villain of the story, the Egyptian priest Arbace. Consistent with the nineteenth century's mainstream view of the superiority of Christian religion compared with ancient practices, the priest is not only depicted as an evil character, obstructing the love story of the good natured protagonist Glauco, but he is also, or mainly, a cynical manipulator who uses the faith of his audience to gain power. In the novel, Arbace simulates a dialogue between the worshippers and the gods,

taking advantage of some hidden areas of the temple. Many of the guidebooks written by English authors in the nineteenth and early twentieth century refer to the stairs on the left of the Temple of Isis as “the secret stairs”, explaining that they were used by the priests to access, unseen, the temple and from there perform their “tricks”. For example, in Engelmann (1904:29)

Besides the flight of steps in front, the temple was approached by means of a secret staircase serving no doubt to give the priests access to the temple unseen by the multitude of the worshippers of Isis.

In the historical footnotes that accompany his novel *The vestal*, Gray (1840:199) says that

[...] beneath the altar is a little chamber where, as it is thought, the priests hid themselves when uttering the response of the oracle. The back part of the temple still presents the little secret staircase leading to the chamber.

Likewise Davenport (1872:148) describe the interior of the temple explaining that

the pedestal was hollow, with two low apertures at the end near the secret stairs so that the priests ascending could enter it unpercieved and astonish the deluded crowd [...].

Both Clarke & Clarke (1847:250) and Dyer (1870:142) assume that part of the temple is built as an area dedicated to the “juggling” of the priests. This interpretation is so natural to the English writers that no explanation for it is given. There is no trace of such strong connotation of “secretness” in the Italian guidebooks, and it is a French writer, Neville Rolfe (1899:140-141), that points out that there is absolutely nothing “secret” about those stairs as they are, actually, in plain sight:

The pillars of the shrine were of the Corinthian order and a brick structure and a brick structure within it is thought by some writers to have been used in connection with oracular trickery, but this seems to us unlikely because there is no attempt at

concealment, which we may suppose be have been a necessary accompaniment of mummery of this kind.

A similar opinion is expressed, in quite sarcastic words, by another French author, Le Monnier (1871):

[...] a vaulted niche is hollowed out beneath the altar, where it served as a hiding-place for the priests,—at least so say the romance-writers. Unfortunately for this idea, the doorway of the recess stood forth and still stands forth to the gaze, rendering the alleged trickery impossible.

5.4. Conclusion

This last chapter discussed how the Pompeian sources have shaped both the 3D visualisations, and the ontology that has been modelled to answer the specific questions posed by the particular data used during this proof of concept. A brief excursus of visual and textual documents has highlighted how external variables like the publishing market and the legal context impact on the documentation, and how errors and mistakes propagate and confirm each other, creating a false idea of certainty.

As this chapter explained, SCOTCH does not aim at describing or cataloguing the sources in detail, nor to cut short issues of authorship. It simply tried to establish connections between the sources, not only based on their relationship with the 3D representation they informed, but also with each other, pointing out patterns and similarity that might have remained hidden otherwise.

6. Conclusions

This work opens with a discussion of one of the most apparent current limitations to the use of 3D visualisation within academia: the lack of detailed and consistent documentation of the modelling process and the sources that have informed it. The absence of footnotes and references, the inexistence of an established system of peer review, the unclear attribution of authorship prevent 3D visualisation from meeting the standards of academic publications. My research argues that this limitation is not intrinsic to the technology, and that the opacity of 3D visualisation can and should be overcome in an academic context.

As pointed out by the London Charter in 2006, the lack of transparency in 3D visualisation is by no means a new issue. Researchers and 3D authors have been concerned with it from the earliest stage of the application of 3D technologies to archaeology and cultural heritage. Various strategies have experimented with the documentation of 3D images produced for scholarly purpose. The different approaches explore a range of, and sometimes mixed, media, registers and means of publication, from dedicated websites to embedded visual codes using different colours or degrees of opacity. However, in the past years, none of these practices has managed to reach enough consensus within the community to become a standard.

This thesis identifies some crucial issues that have impacted negatively on the development of a documentation framework for 3D visualisation, and, as a consequence, on the use and perception of 3D images in academia. The first major obstacle is that the attention of the public, and of the scholarly community, is still mostly oriented towards the finished visual product and its aesthetic qualities, more than to the process of representation and the research that supported it. Therefore 3D visualisations of cultural heritage are often perceived as communicative devices, meant to illustrate external research more than a means of producing new information. In other words, they are usually considered as a visual aid to appeal to a non expert public.

The strong focus on the final outcome has made it difficult for 3D authors in academia to argue that documentation of the process is as much important, if not more, than the finished and rendered 3D file, and to convince funding bodies and fellow scholars that documentation is not an optional appendix of a scientific 3D visualisation, but something that should be always delivered along with the visual output. This general overlook of documentation is amplified by

the methodological and technological difficulties connected with both a complex field such as cultural heritage and new and demanding technology such as 3D visualisation. As a result, the available documented 3D visualisations show an high level of idiosyncrasy that make them neither comparable nor cross searchable.

In this research, I claim that not only scholarly 3D visualisation needs to be documented, but also that the documentation needs to develop within a common methodological framework that allows for the different representations to be compared. The idea of embedding documentation into the 3D visualisation workflow is likely to meet resistance from both the cultural institutions that commissioned the product, that do not want to pay for something that they consider only an accessory, and the community of practitioners, that will have to change at least in part their established *modus operandi*. Therefore, it is crucial that the envisioned documentation standard is time - and cost - effective. Integrating a 3D visualisation with its detailed documentation should not mean adding a level of complication for the authors and a new challenge for preservation. On the contrary, the standard for documentation should be easy to learn and apply for the authors, and easy to maintain for the curators.

Looking at the desirable qualities of a 3D documentation standard highlighted by this analysis, the use of a XML based technology like RDF Linked Open Data configured as a very suitable choice, in many respects. XML-RDF is a standard format developed by the W3 Consortium, with the specific scope of expressing metadata about digital resources, in the form of subject-predicate-object statements (also known as “triples”). The format is lightweight and easy to preserve. Being based on a controlled vocabulary, RDF is also a natural choice for a standard, being both synthetic and based on a precise definition of classes and properties (an ontology) that is always formally declared and available online.

An analysis of the current panorama of field ontologies, revealed that none of the existing ones offered a conceptual model suitable for describing the research process behind a 3D visualisation and its sources. For this reason, I decided to create a first set of classes and properties *ad hoc*. The ontology, named SCOTCH, is meant to be developed by the community of 3D authors that work in academia. However, in the context of this doctoral thesis, I have drafted its theoretical framework and fundamental elements, and applied it experimentally to document my own 3D visualisation.

Besides the obvious benefits of introducing a synthetic and standardised documentation into the 3D visualisation products, the task of creating a dedicated ontology to describe the research workflow supporting 3D images highlighted a wider and more radical range of opportunities offered by the encounter of 3D models with RDF Linked Data and a bespoke ontology.

Dividing, conceptually, the space into parts, and assigning each of them a unique resource identifier (URI), allows 3D authors to express information on different levels. In the first place, to model the space and the relationship between its parts, then relating each part to its multiple representations in words and images, including, but not limited to, 3D visualisation. Lastly, it connects each 3D representation to the sources that have informed its development.

The non hierarchical structure of RDF Linked Data enables an unlimited number of contributors to add statements about the spatial elements and their interpretations, as well as variant 3D representations, all documented and related to the relevant sources.

Such an approach can change dramatically the role of 3D visualisation in academic research, finally shifting the attention from the final visual product, to the process of gathering information around it, the multiple interpretations of cultural heritage, and the existence of various, sometimes conflicting, narratives and sources. Each 3D visualisation developed within the SCOTCH framework will be fully documented, hence closer to an academic publication, but also part of a dynamic network of information that is collaborative, open-ended and multivocal.

In order to show, and discuss, the potential of the SCOTCH documentation framework I have produced, as a proof of concept, two related 3D visualisations of a piece of ancient cultural heritage and I have documented it entirely in RDF triples, using the SCOTCH ontology.

The choice of the case study has fallen on Pompeii for several reasons, but mainly because of both its long history as an archaeological site and its almost uninterrupted success among different audiences, from professional archaeologists to simple tourists. Due to its popularity, and to the emotional response solicited by its tragic destiny, Pompeii has generated an unprecedented quantity of documentation, in various media and various degrees of quality and reliability. As its popularity continues in the present day, Pompeii is also involved in a number of digitisation process, making documents such as historical secondary sources available online, and ready to be effectively included in a Linked Data environment. The life of the archaeological site throughout more than two hundred and fifty years is also an opportunity

to expose the evolution and contraposition of narratives and interpretations of the archaeology. In this respect Pompeii offers, possibly better than any other site, the chance to link, and compare, different representations and interpretations to the same object.

Both historical and contemporary documents concerned with Pompeii perform, then, two roles. On the one hand they can be connected to a specific 3D visualisation when they have been chosen as source of information for one of its parts. On the other, they can be linked to the URIs of the spatial elements they refer to, and contribute to create a diverse and multifaceted representation of the knowledge around them.

The Iseum has been chosen from amongst the many Pompeian buildings because of its early discovery during the excavations, and its iconicity in the city's landscape. The Iseum, and in particular the Temple of Isis, were an unmissable stop during the Grand Tour, highly recommended in every single guidebook during those years. The connotation of the buildings, in both verbal and visual descriptions, went from a mysterious place ruled by manipulative Egyptian priests, to the very embodiment of the pure reason.

To show the performance of SCOTCH in documenting a single 3D visualisation, but also in connecting the variant visualisations to the same conceptual space, I have produced two models of the space of the Iseum. One represents the hypothetical look of the place around the year of eruption, 79 AD, and the other the hypothetical look of the Iseum when it was first excavated, and during the early years of the Grand Tour. The comparison between the two models points out how different the visualisations of the same place can be, even when produced by the same author, when they focus on different research questions and have different purposes. Moreover, correlation between the two 3D visualisation tries to capture the complex and fluid nature of cultural heritage, and how it changes and evolves in a way that closely resemble that of a living creature; a continuously reshaped nature that a an open-ended and collaborative framework seems more apt than others to represent.

The classes and properties in SCOTCH have been created through an analysis of the actual sources, and their use during the specific modelling process. This workflow, that proceed from the particular to the general, has enabled the creation of classes and properties able to model the specific challenges posed by Pompeii and its fragmented and sometimes controversial documentation.

Unlike other documentation approaches that aim at identifying the level of reliability of the sources that informed the 3D modelling, the purpose of SCOTCH is not to assess the quality of the sources. The goal of SCOTCH is to document the modelling process of an historical object or place, and to connect its different representations and interpretations. Therefore, SCOTCH does not evaluate the sources, but simply attests which ones have been used as references for a specific 3D visualisation, and assigns them to a typology that is tied to their provenance.

Classifying the sources, according to their nature and not their alleged reliability, can be considered the pivotal function of the SCOTCH ontology. SCOTCH distinguishes between seven types of sources that can be used as a reference when developing a 3D visualisation. The first one, “primary”, groups those documents that contain first hand information—especially measurements—about objects that are still on site (and, thus, can be potentially re measured). The second one, “secondary” refers to historical sources that have documented objects that no longer exist, or that have been heavily modified. Under the label “derived” can be found the information about disappeared objects that is geometrically or logically derived from material clues (still standing or documented). The largest class, “guessed” is used to identify the information that does not come directly from the represented object, but from an external, citable sources such as previous scholarship, established canons or relevant precedents. I was especially interested in modelling, via SCOTCH, those cases for which there is not any citable source to point to as a source of information but about which the authors rely on their field knowledge and expertise. The class “speculative” has been then created for this specific purpose. Two more categories, “contextual” and “fictional” has been added for the sources that informed those elements that do not have any strict historical or academic purpose. SCOTCH does not assume historical accuracy as the obvious aim of a 3D visualisation, and allows, potentially, all degrees of speculation, as long as they are clearly documented.

When the sources of a 3D visualisation are citable entities, the SCOTCH documentation will link to them, either as digital facsimile or bibliographical reference. When the sources are not citable entities, a URI is assigned to each guess, and an author and date are associated to it.

In this thesis I claim that the process of documentation of 3D visualisation has been, thus far, overlooked as a practice and over simplified as a concept. The popular documentation

strategy that invites one to divide the different elements of a 3D visualisation into “layers” and assign to each of them a value of “certainty” not only assumes that the reliability of the sources can be objectively quantified, but also ignores the complexity of the research process and does not portray the multiplicity of sources that are often used as references even for the same single spatial element. A different approach has been suggested to deal with this heterogeneity and, in SCOTCH, a URI has been minted not only for each spatial element and for each of its 3D representations, but also for each dimension of each 3D representation: height, length, depth. In this way, SCOTCH is able to assign the precise source of information to each of the dimensions of a spatial element (components), reaching an unprecedented granularity in the documentation of a 3D visualisation. To test the capacity of the framework in this perspective, the two representations of the Iseum have been modelled in 3D without pursuing consistency nor having a specific archaeological theory in mind. On the contrary, the maximum degree of diversity has been used as criterion for the selection of sources.

The value of this proof of concept can be found more in its being a theoretical framework and a starting point for discussion than in the particular specifications here presented. Its aim is to highlight the methodological and technological challenges of a LOD based documentation but also its opportunities.

I claim that a documentation model such SCOTCH is able to radically change the perception of 3D visualisations in academia. It will disassociate it from that idea of opacity that still provokes an understandable diffidence in the scholarly community, and will enable a level of transparency that can be compared to that of critical editions. Connecting variant visualisation of the same object or place will also challenge the misconception that 3D visualisation should aim at an impossible representations of the things “as they were” in the past; a misleading idea that confuses the audience and diminishes the richness of cultural heritage. A SCOTCH documentation will highlight that 3D visualisation has always a speculative component, and that it is often impossible to state that one hypothesis is definitely more accurate than another. In this sense, the network, potentially created via LOD, of multiple visualisations developed by different authors and research groups, will embody a new concept of scholarly 3D visualisation as virtual a space for study, simulation, testing and not just as a snapshot of the past. In addition, a Linked Open Data approach enables the connection of different 3D visualisations to the same referent, but also connections between the latter and other interpretations produced in different

moments of time and by actors belonging to different groups, making the graph of information around the referent more diverse and multivocal.

One last benefit of a LOD-based standard for documentation of 3D visualisation is that forcing the 3D authors to think about their workflow and formalising their acts and decision will make transparent not only the final product, but also the methodology that has been followed. In this scenario, documented 3D visualisations will be seen as valuable pieces of research around the referent, as a compass to navigate diverse information about the latter and, also, as an implicit methodological lesson on how to conduct research in this field, how to analyse the different sources and how to assess them.

The history of classics, and of the humanities in general, is full of examples of brilliant systems for studying, interpreting and cataloguing objects, either material or conceptual. Such systems, as striking and effective as they are, defeat the scholarly purpose in their not being explained and thus, not replicable by other researchers. Too often, a wealth of knowledge is doomed to disappear with its creator. Relying on some sort of undefinable expertise is very common in the humanities, from the decoding of epigraphic material to the identification of hands in ancient pottery decoration. However, knowledge and methodologies are not abstract, and are based on the application of subsequent steps. When those steps are documented, then the process survives and can be implemented and refined.

My work claims that 3D visualisation has the potential to become a virtual laboratory, where ideas can be tested and compared; a research space where different voices can be expressed but no reading can be imposed over others. The view of 3D visualisation advocated by SCOTCH framework leaves behind the idea of aesthetically appealing images, often produced by professional graphics that have little or no ties with the historical research, and promotes, instead, a new, specifically academic 3D visualisation that is documented, open, collaborative and is an organic part of the growing Linked Open Data ecosystem.

Bibliography

AAVV (2014) *Wohlers Report 2014. Additive Manufacturing and 3D Printing State of the Industry. Annual Worldwide Progress Report*. Wohlers Associate.

AAVV (2015) *Pompei e l'Europa (1748-1943). Catalogo della mostra (Napoli, 26 maggio-2 novembre 2015)*. Mondadori Electa. 2015

Addison, A. C. (2007). *The Vanishing Virtual*. Kalay, Y., Kvan, T., & Affleck, J. (Eds.). New heritage: New media and cultural heritage. Routledge.

Ahmad, Y. (2006). *The scope and definitions of heritage: From tangible to intangible*. International journal of heritage studies, 12(3), 292-300.

Alatrish, E. S. (2013) *Comparison Some of Ontology Editors*. Journal of Management Information Systems 8, no. 2 (2013): 018-024.

Anderson, M. (2008). *Putting the "reality" in virtual reality: new advances through game engine technology*. Posluschny, A., Lambers, K. and Herzog, I. (eds.): Layers of Perception. Proceedings of the 35th International Conference on Computer Applications and Quantitative Methods in Archaeology (CAA), Berlin, 2.-6. April, 2007

Ankersmit, F. R. (2001). *Historical Representation*: FR Ankersmit. Stanford University Press.

Arslan, E. (ed) (1997) *Iside: il mito, il mistero, la magia*. Milano, Electa (1997)

Baker, D. (2012). *Defining Paradata in Heritage Visualization*. Bentkowska-Kafel, A., Denard, H. and Baker, D. (eds) (2012). Paradata and Transparency in Virtual Heritage, Ashgate.

Bakker, G., Meulenberg, F., & Rode, J. D. (2003). *Truth and credibility as a double ambition: reconstruction of the built past, experiences and dilemmas*. The Journal of Visualization and Computer Animation, 14(3), 159-167.

Ballatore, A. (2016). *Prolegomena for an Ontology of Place. Advancing Geographic Information Science: The Past and Next Twenty Years*, 91.

Barthes, R. (1993). *Rhetoric of the Image*. mage-Mustc-Text.

Baudrillard, J. (1983). *Simulations*. Trans by Paul Foss, Paul Patton, and Philip Beitchman. New York: Semiotext(e), 1983.

Bauer, F., & Kaltenböck, M. (2011). *Linked open data: The essentials*. Edition mono/monochrom, Vienna.

Baum, C. (2011). *Ruined Waking Thoughts: William Beckford as a Visitor to Pompeii*. In Hales, S., & Paul, J. (eds.) (2011). Pompeii in the Public Imagination from its Rediscovery to Today. Oxford University Press.

- Beacham, R., Baker, D., Blazeby, M. & Denard, H.** (2013) *The Visualisation of the Boscoreale Villa in 3-D*. In *Les Fresques Romaines de Boscoreale: Perspectives Actuelles*. . Musée royal de Mariemont, Brussels.
- Beard, M.** (2008) *Pompeii: The Life of a Roman Town*. London, Profile Books Limited, 2009
- Becker, A. S.** (1995). *The Shield of Achilles and the Poetics of Ekpharsis*. Rowman & Littlefield Publishers.
- Behr, J., Froehlich, T., Knoepfle, C., Kresse, W., Lutz, B., Reiners, D., ... & Ehr, J.** (2001). *The Digital Cathedral of Siena--Innovative Concepts for Interactive and Immersive Presentation of Cultural Heritage Sites*.
- Blazeby, M., Baker, D.** (2013) *The Villa of Oplontis: Interactive navigable 3D model*. Digital or Visual Products, The American Council of Learned Societies.
- Blix, G. M.** (2009). *From Paris to Pompeii: French romanticism and the cultural politics of archaeology*. Univ of Pennsylvania Press.
- Bogost, I.** (2008) *The Rhetoric of Video Games*. In Salen, K. (ed) (2008) *The Ecology of Games: Connecting Youth, Games, and Learning*. The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning. Cambridge, MA: The MIT Press, 2008. 117–140.
- Bohrer, F. N.** (2011). *Photography and archaeology*. Reaktion books.
- Bon, S. E. and Jones, R.** (1997). *Sequence and space in Pompeii*. Oxford: Oxbow Books
- Borra, D.** (2009). *L'anastilosi virtuale della torre di vendicari. La torre di vendicari. Un'architettura che nasce e si sviluppa dal mare*. Lombardi, Siracusa, 173-202.
- Brand, S.** (1994). *How buildings learn: What happens after they're built*. Penguin.
- Cameron, F and Robinson, H.** (2007). *Digital Knowledge Scapes: Cultural, Theoretical, Practical and Usage Issues Facing Museum Collection Databases in a Digital Epoch*. Cameron, F. and Kenderdine, S. (eds) (2007). *Theorizing Digital Cultural Heritage. A critical discourse*. Cambridge, MA: MIT Press
- Castaldi, G.** (1840). *Della Regale Accademia Ercolanese dalla sua fondazione sinora con un cenno biografico de'suoi soci ordinari*.
- Champion, E.** (2011) *Playing with the Past*. London:Springer 2011.
- Champion, E. and Dave, B.** (2007) *Dialing Up the Past*. Cameron, F. and Kenderdine, S. (eds) (2007). *Theorizing Digital Cultural Heritage. A critical discourse*. Cambridge, MA: MIT Press
- Chaney, E.** (1998) *The Evolution of the Grand Tour*. London: Frank Cass Publishers
- Chard, C.** (1999). *Pleasure and guilt on the Grand Tour: travel writing and imaginative geography, 1600-1830*. Manchester University Press, 1999.

Ciula, A., & Pasin, M. (2009). *Laying the conceptual foundations for data integration in the humanities*. Abstract from Digital Humanities 2009, College Park (Washington), United States.

Copeland, T. (2004). *Presenting Archaeology to the Public*. In Merriman, N. (ed). Public Archaeology. London/New York: Routledge, 2005

Cooke, W. B. (1827) *Pompeii, illustrated with picturesque views, engraved by W. B. Cooke, from the original drawings of lieut. col. Cockburn ... and with plans and details of the public and domestic edifices, including the recent excavations, and a descriptive letterpress to each plate, by T. L. Donaldson, architect ... in two volumes*. Vol. I. London, 1827

Cooley, M. G. L., & Cooley, A. E. (2004). *Pompeii and Herculaneum: A Sourcebook*. Routledge.

D'Alconzo, P. (2002) *Picturae excisae: conservazione e restauro dei dipinti ercolanesi e pompeiani tra XVIII e XIX secolo*. Roma : "L'Erma" di Bretschneider

Dal Maso, C. (2013). *Pompeii: Under the Sign of Isis*. 24 ore cultura.

De Caro, S. (1992) *La scoperta, il santuario, la fortuna*. In De Caro, S. (ed) Alla Ricerca di Iside: analisi, studi e restauri dell'Isola pompeiana nel Museo di Napoli. Soprintendenza archeologica per le province di Napoli e Caserta. Museo Archeologico Nazionale di Napoli.

De Carolis, E., & Patricelli, G. (2003). *Vesuvius, AD 79: the destruction of Pompeii and Herculaneum*. Getty Publications.

De Venuti, N. M. (1749). *Descrizione delle prime scoperte dell'antica città d'Ercolano, ritrovata vicino a Portici*. 1749. Napoli

Della Corte, M., (1965). *Case ed Abitanti di Pompei*. Napoli: Fausto Fiorentino

Delmont, E. (1993) *The Voortrekker Monument: Monolith to Myth*, South African Historical Journal, 29:1, 76-101, DOI: 10.1080/02582479308671763

Denard, H. (2012) *A New Introduction to the London Charter*. In Bentkowska-Kafel, A., Denard, H. and Baker, D. (eds.) (2012) *Paradata and Transparency in Virtual Heritage*, Ashgate.

Devlin, K. (2012) *Just how predictable is predictive lighting?* In Bentkowska-Kafel, A., Denard, H. and Baker, D. (eds.) (2012) *Paradata and Transparency in Virtual Heritage*, Ashgate.

Di Mascio, D., Chiuini, M., Fillwalk, J., & Pauwels, P. (2016) *3D Digital Reconstructions of Lost Buildings*.

Doerr, M., & LeBoeuf, P. (2007). *Modelling intellectual processes: the FRBR-CRM harmonization*. In Digital libraries: Research and development (pp. 114-123). Springer Berlin Heidelberg.

Dwyer, E. J. (2010). *Pompeii's Living Statues: Ancient Roman Lives Stolen from Death*. University of Michigan Press.

Earle, N., & Hales, S. (2009, July). *Pompeii in the crystal palace: comparing victorian and modern virtual, immersive environments*. In EVA 2009 Electronic Visualisation in the Arts Conference, British Computing Centre (pp. 37-46).

Eco, U. (1990). *Interpretation and overinterpretation: world, history, texts. The Tanner Lectures on Human Values*.

Elia, O. (1941) *Le Pitture del Tempio di Iside*. Roma: Istituto Poligrafico dello Stato, 1941

Ezquerro, J. A. (2008). *Romanising oriental Gods: myth, salvation, and ethics in the cults of Cybele, Isis, and Mithras* (Vol. 165). Brill.

Favro, D. (2006) *In the eyes of the beholder: Virtual Reality Recreations and academia*. Journal of Roman Archaeology Supplementary Series Number 61(2006): 321-334.

Favro, D. (2012). *Se non è vero, è ben trovato (If Not True, It Is Well Conceived)*. Journal of the Society of Architectural Historians, 71(3), 273-277.

Favro, D., & Johanson, C. (2010). *Death in motion: Funeral processions in the Roman forum*. Journal of the Society of Architectural Historians, 69(1), 12-37.

Fiorelli, G. (1864) *Pompeianarum antiquitatum historia: quam ex cod. mss. et a schedis diurnisque R. Alcubierre, C. Weber, M. Cixia, I. Corcoles, I. Perez-Conde, F. et P. La Vega, R. Amicone, A Ribav, M. Ardit, N.D'Apuzzo ceteror, Volume 1*. Napoli

Fizon, T. (2011) A tamed 'desire for images': Goethe's Repeated Approaches to Pompeii. In Hales, S., & Paul, J. (Eds.). (2011). *Pompeii in the Public Imagination from its Rediscovery to Today*. Oxford University Press.

Fondazione Giorgio Cini & Factum Arte (2012) *The arts of Piranesi : architect, etcher, antiquarian, vedutista, designer*. Venezia : Giorgio Cini; Madrid : Factum Arte.

Forte, M. (Ed.). (2007). *La villa di Livia: un percorso di ricerca di archeologia virtuale* (Vol. 41). L'Erma di Bretschneider.

Forte, M. (2012) *Cyberarchaeology: a Post-Virtual Perspective*

Forte, M. (2000) *About Virtual Archaeology: Disorders, Cognitive Interactions and Virtuality*. In Barcelo J., Forte M., Sanders D. (eds.) (2000) *Virtual Reality in Archaeology*, BAR International Series S 843 (Oxford, ArchoPress) 247-263

Forte, M. and Pietroni, E. (2009) *3D Collaborative Environments in Archaeology: Experiencing the Reconstruction of the Past*. International Journal of Architectural Computing Issue 01, Vol. 07, March 2009, 57-75.

Fredrick, D. (2011) *Time.deltaTime: The Vicissitudes of Presence in Visualizing Roman Houses with Game Engine Technology*

Frisher, B. (2008). *The Rome Reborn Project. How Technology is helping us to study history*.

- Frischer, B. and Fillwalk, J.** (2012) *The Digital Hadrian's Villa Project: Using virtual worlds to control suspected solar alignments*. 18th International Conference on Virtual Systems and Multimedia (VSMM), 2012
- Frischer B., Niccolucci F., Ryan N., Barcelò J.** (2002) *From CVR to CVRO. The Past, Present, and Future of Cultural Virtual Reality*. In F. Niccolucci (ed) *Proceedings of VAST 2000*. British Archaeological Reports 834 (ArcheoPresss, Oxford) 7-18.
- Garcia y Garcia, L.**, (2006). *Danni di guerra a Pompei*. Rome: L'Erma di Bretschneider.
- Gardner Coates, V. C., & Seydl, J. L.** (2007). *Antiquity recovered. The Legacy of Pompeii and Herculaneum*. Los Angeles, CA; Getty Publications
- Gill, T.** (2004). *Building semantic bridges between museums, libraries and archives: The CIDOC Conceptual Reference Model*. First Monday, 9(5).
- Glancey, J.** (2008). *Lost buildings: demolished, destroyed, imagined, reborn*. Goodman.
- Gosden, C.** (2005). *What do objects want?*. Journal of archaeological method and theory, 12(3), 193-211.
- Gosden, C., & Marshall, Y.** (1999). *The cultural biography of objects*. World archaeology, 31(2), 169-178.
- G. Goodrick and G. Earl** (2004) *A manufactured past: virtual reality in archaeology*. Internet Archaeology 15
- Guidi, G., Beraldin, J. A., & Atzeni, C.** (2004). *High-accuracy 3D modeling of cultural heritage: the digitizing of Donatello's "Maddalena"*. IEEE Transactions on image processing, 13(3), 370-380.
- Gusman, P.** (1900). *Pompei, the City, Its Life & Art*. W. Heinemann.
- Hales, S., & Paul, J.** (Eds.). (2011). *Pompeii in the Public Imagination from its Rediscovery to Today*. Oxford University Press.
- Harris, J.** (2007). *Pompeii awakened: a story of rediscovery*. IB Tauris.
- Hermon, S.** (2008) *Reasoning in 3D: a Critical appraisal of the role of 3D modelling and virtual reconstructions in archaeology*. In Frischer, B and Dakouri-Hild, A. (eds) *Beyond Illustration: 2D and 3D Digital Technologies as Tools for Discovery in Archaeology*, BAR International Series 1805 (Oxford)
- Hodder, I.** (2012) *Entangled: An Archaeology of the Relationships Between Humans and Things*. John Wiley & Sons
- Hodder, I., & Hutson, S.** (2003). *Reading the past: current approaches to interpretation in archaeology*. Cambridge University Press.
- Jacobelli. L.** (2008) *Pompei tra Mito e Turismo*. In Jacobelli L. (ed) *Pompei la Costruzione di un Mito*. Roma: Bardi Editore

Jacobelli, L. (2011). *Pompei nell'Unità d'Italia*. Flavius Editore.

Jacobson, J. (2005p) *The Virtual Pompeii Project*. Paper downloaded from the project's website at http://publicvr.org/html/pro_pompeii.html

James, S. (1997) *Drawing Inferences*. In Molyneaux, B. L. (ed.) *The Cultural Life of Images. Visual Representation in Archaeology*. Routledge, London 2011

Jenkins, I. (2001). *Cleaning and controversy: the Parthenon sculptures 1811-1939*. Trustees of the British Museum.

Joy, J. (2009). *Reinvigorating object biography: reproducing the drama of object lives*. *World Archaeology*, 41(4), 540-556.

Johanson, C. (2009). *Visualizing History: Modeling in the Eternal City*. *Visual Resources: An International Journal of Documentation*, 25:4, 403-418

Jones, M. W. (2003). *Principles of Roman Architecture*. Yale University Press.

Koller, D., Frischer, B., & Humphreys, G. (2009). *Research challenges for digital archives of 3D cultural heritage models*. *journal on computing and cultural heritage (JOCCH)*, 2(3), 7.

Koutsoudis, A., Arnaoutoglou, F., & Chamzas, C. (2007). *On 3D reconstruction of the old city of Xanthi. A minimum budget approach to virtual touring based on photogrammetry*. *Journal of Cultural Heritage*, 8(1), 26-31.

Lazer, E. (2009). *Resurrecting pompeii*. Routledge.

Leppmann, W. (1968) *Pompeii in Fact and Fiction*. London:Eleks Books Limited, 1968

Leslie, M. (1994). *Bitter monuments: Afrikaners and the new South Africa*. *The Black Scholar*, 24(3), 33-39.

Levin, Y. (2005). *Conrad, Freud, and Derrida on Pompeii: A paradigm of disappearance*. *Partial Answers: Journal of Literature and the History of Ideas*, 3(1), 81-99.

Limp, F., Payne, A., Simon, K., Winters, S. and Cothren, J. (2011) *Developing a 3D digital heritage ecosystem: from object to representation and the role of a virtual museum in the 21st century*

Lyons, C. L., & Reed, M. (2007). *The visible and the visual: Pompeii and Herculaneum in the Getty Research Institute collections*. In Gardner Coates, V. C., & Seydl, J. L. (eds.) (2007). *Antiquity recovered. The Legacy of Pompeii and Herculaneum*. Los Angeles, CA; Getty Publications

Lowenthal, D. (1998) *Fabricating Heritage*. *History and Memory*, Vol. 10, No. 1 (Spring 1998), pp. 5-24.

Mattush, C., Winckelmann, J. J. (2011). *Letter and Report on the Discoveries at Herculaneum*. Getty Publications.

- McCarty, W.** (2004). *Modeling: a study in words and meanings*. A companion to digital humanities, 254-270.
- McEwen, I. K.** (2003). *Vitruvius: writing the body of architecture*. MIT press.
- MacGillivray, J. A.** (2001). *Minotaur: Sir Arthur Evans and the archaeology of the Minoan myth* (Vol. 471). Vintage.
- Merriman, N.** (Ed.). (2004). *Public archaeology*. Routledge.
- Messham-Muir, K.** (2005). Affect, Interpretation and Technology. *Open Museum Journal*: 7, 2005
- Miller, E. J.** (2001). *An introduction to the resource description framework*. Journal of library administration, 34(3-4), 245-255.
- Mitchell, K.** (2003). *Monuments, memorials, and the politics of memory*. Urban Geography, 24(5), 442-459.
- Niccolini, F. & F.** (1854) *Le case ed i monumenti di Pompei: Volume Primo*. Napoli 1854
- Niccolucci, F.** (2012). *Setting standards for 3D visualization of cultural heritage in Europe and beyond*. Paradata and Transparency in Virtual Heritage. Ashgate, Burlington, 23-36.
- Niccolucci, F., & D'Andrea, A.** (2006, October). *An ontology for 3D cultural objects*. In Proceedings of the 7th International conference on Virtual Reality, Archaeology and Intelligent Cultural Heritage (pp. 203-210). Eurographics Association.
- Yastikli, N.** (2007). *Documentation of cultural heritage using digital photogrammetry and laser scanning*. Journal of Cultural Heritage, 8(4), 423-427.
- Ore, C. E., & Eide, Ø.** (2009). *TEI and cultural heritage ontologies: Exchange of information?*. Literary and Linguistic Computing, 24(2), 161-172.
- Paliou, E., Wheatley, D., Earl, G. P.** (2011) *Three-dimensional visibility analysis of architectural spaces: iconography and visibility of the wall paintings of Xeste 3 (Late Bronze Age Akrotiri)*. Journal of Archaeological Science. 38:375-386.
- Pakkanen, J.** (2002). *Deriving ancient foot units from building dimensions: a statistical approach employing cosine quantogram analysis*. BAR INTERNATIONAL SERIES, 1016, 501-506.
- Pakkanen, J.** (2004). *The temple of Zeus at Stratos: New observations on the building design*. Arctos: acta philologica fennica, (38), 95-122.
- Parry, R.** (2007). *Recoding the Museum: Digital Heritage and the Technologies of Change*. London: Routledge
- Phillips, J. E.** (2005). *"To Make the Dry Bones Live": Amédée Forestier's Glastonbury Lake Village*. Envisioning the Past: Archaeology and the Image, 72-91.

- Powers, S.** (2003). *Practical rdf*. O'Reilly Media, Inc..
- Rapoport, A.** (1982) *The Meaning of the Built Environment: A Nonverbal Communication Approach*. Tucson:University of Arizona Press, 1990
- Reilly, P.** (1991) *Towards a virtual archaeology*. In, CAA 90 (at <http://eprints.soton.ac.uk/353058/>)
- Rodriguez, M. D. C. A.** (2008). *Venerdì a Portici: il Museo Ercolanese nei ricordi di Carlo III*. Herculaneum Museum: laboratorio sull'antico nella Reggia di Portici, 105.
- Roussou, M.** (2004). *Learning by doing and learning through play: an exploration of interactivity in virtual environments for children*. Computers in Entertainment (CIE), 2(1), 10-10.
- Saldaña, M.** (2015). *An Integrated Approach to the Procedural Modeling of Ancient Cities and Buildings*. Digital Scholarship in the Humanities, 30(suppl 1), i148-i163.
- Sampaolo, V.** (1992) *La decorazione pittorica*. In De Caro, S. (ed) *Alla Ricerca di Iside: analisi, studi e restauri dell'Iseo pompeiano nel Museo di Napoli*. Soprintendenza archeologica per le province di Napoli e Caserta. Museo archeologico nazionale di Napoli.
- Sanders, R.** (2016) Keynote speech at the Linked Pasts conference. Madrid, 14-15 December 2016.
- Schedler, G.** (2001). *Are Confederate monuments racist?*. International Journal of Applied Philosophy, 15(2), 287-308.
- Scheid, J.** (2003). *An introduction to Roman religion*. Indiana University Press.
- Shanks, M.** (2009) *The Archaeological Imagination*. Left Coast Press Inc
- Smiles, S., & Moser, S. (Eds.).** (2008). *Envisioning the Past: Archaeology and the Image*. John Wiley & Sons.
- Stanco, F., Battiato, S., & Gallo, G. (Eds.).** (2011). *Digital imaging for cultural heritage preservation: Analysis, restoration, and reconstruction of ancient artworks*. CRC Press.
- Stanco, F., Tanasi, D., Buffa, M. and Basile, B.** (2011) *Augmented perception of the past. The case of the Telamon from the Greek theater of Syracuse*. Proceedings of the International Workshop on Multimedia for Cultural Heritage (MM4CH 2011), Modena, May 3, 2011, pp. 1-10.
- Stoppani, T.** (2013). *Material and critical: Piranesi's erasures*.
- Stojanovic, L., & Motik, B.** (2002, September). *Ontology evolution within ontology editors*. In Proceedings of the OntoWeb-SIG3 Workshop (pp. 53-62).
- Thompson, W.** (2000). *"The Symbol of Paris": Writing the Eiffel Tower*. French Review, 1130-1140.
- Tret'iakov, S.** (2006). *The biography of the object*.

- Trigger, B. G.** (1989). *A history of archaeological thought*. Cambridge University Press.
- Tudhope et al.** (2011) *Connecting Archaeological Data and Grey Literature via Semantic Cross Search*, Internet Archaeology 30. <http://dx.doi.org/10.11141/ia.30.5>
- Ulrich, R. B.** (2007). *Roman woodworking*. Yale University Press.
- Unold, M., & Lange, F.** (2014). *Relating texts to 3D-information: A generic software environment for Spatial Humanities*. Digital Humanities' 14 (DH 2014).
- Urry, J. and Larsen, J.** (2011) *The Tourist Gaze 3.0*. Los Angeles/London: SAGE, 2011
- Uschold, M.** (1996). *Building ontologies: Towards a unified methodology*. TECHNICAL REPORT-UNIVERSITY OF EDINBURGH ARTIFICIAL INTELLIGENCE APPLICATIONS INSTITUTE AIAI TR.
- Van Den Berk, M. F. M.** (2004). *The Magic Flute*. Brill. p.450
- Vidler, A.** (1992). *The architectural uncanny: essays in the modern unhomely*. MIT press.
- Vitale, V.** (2012). *Can Digital Unification Enhance Cultural Encounters? The Temple of Isis at Pompeii, a Case Study*. King's College London. Masters Thesis in Digital Humanities.
- Vitale, V.** (2016). *Transparent, Multivocal, Cross-disciplinary: The Use of Linked Open Data and a Community-developed RDF Ontology to Document and Enrich 3D Visualisation for Cultural Heritage*. In: Romanello M. & Bodard G, Digital Classics Outside the Echo-Chamber. London: Ubiquity Press.
- Walsh, K.** (1992). *The representation of the past: museums and heritage in the post-modern world*. Routledge.
- Waugh, E.** (1930). *Labels: A Mediterranean Journal*. Penguin Classics; New Ed edition. 1995
- Webb, N.** (2012). *Digital Re-analysis of Lost or Unbuilt Architecture*. (PhD Thesis, University of Liverpool).
- Wilton-Ely, J.** (2013). *Piranesi, Paestum & Soane*. London: Prestel.
- Witcomb, A.** (2010). Remembering the dead by affecting the living: the case of a miniature model of Treblinka. *Museum materialities: objects, engagements, interpretations*, 39-52.
- Witt, R. E.** (1997). *Isis in the ancient world*. JHU Press.
- Zimmerman, V.** (2009). *Excavating Victorians*. SUNY Press.
- Zimmerman, L. J., Vitelli, K. D., & Hollowell, J. J.** (2003). *Ethical issues in archaeology*. Rowman Altamira.

Web Resources

Wikipedia: Resource Descriptive Framework. Available at https://en.wikipedia.org/wiki/Resource_Description_Framework (accessed 31 October 2016)

W3C: RDF Semantics <https://www.w3.org/TR/2004/REC-rdf-mt-20040210> (accessed 31 October 2016)

W3C: Resource Description Framework (RDF): Concepts and Abstract Syntax. <https://www.w3.org/TR/2004/REC-rdf-concepts-20040210/> (accessed 31 October 2016)

Stanford Protégé Documentation Wiki. Available at <http://protegewiki.stanford.edu/wiki/ProtegeDesktopUserDocs> (Accessed 31 October 2016)

Wikipedia: Ontology (Information Science). Available at [https://en.wikipedia.org/wiki/Ontology_\(information_science\)](https://en.wikipedia.org/wiki/Ontology_(information_science)) (Accessed 31 October 2016)

W3C: XML Schema Datatypes in RDF and OWL. Available at <https://www.w3.org/TR/swbp-xsch-datatypes/> (accessed 31 October 2016)

A Practical Guide To Building OWL Ontologies Using Protégé 4 and CO-ODE Tools Edition 1.3. Available at: http://mowl-power.cs.man.ac.uk/protegeowltutorial/resources/ProtegeOWLTutorialP4_v1_3.pdf (accessed 1 November 2016)

Dublin Core Vocabulary. Available at <http://dublincore.org/documents/dcmi-terms/> (accessed 1 November 2016)

W3C RDF Primer. Available at <https://www.w3.org/TR/2004/REC-rdf-primer-20040210/> (accessed 1 November 2016)

The London Charter. Available at <http://www.londoncharter.org/> (accessed 24 November 2016)

A Roman Centurion in London. Ashmolean Museum Blog. Available at <http://www.ashmolean.org/ashwpress/latininscriptions/2014/03/10/a-roman-centurion-in-london/> (accessed 25 November 2016)

CyArk Makes Dreams of Teleportation Come True with VR at SF's Exploratorium (2016). Available at <http://www.cyark.org/news/cyark-makes-dreams-of-teleportation-come-true-with-vr-at-sfs-exploratorium> (accessed November 2016)

The Sevilla Charter: Principles. Available at <http://smartheritage.com/seville-principles/seville-principles> (accessed 25 November 2016)

Europeana Labs Documentation. Available at <http://labs.europeana.eu/api> (accessed 26 November 2016).

W3C: Best Practices for Publishing Linked Data. Available at <https://www.w3.org/TR/ld-bp/> (accessed 26 November 2016)

The Text Encoding Initiative. Available at: <http://www.tei-c.org/index.xml> (Accessed 30 November 2016)

The Music Encoding Initiative. Available at: <http://music-encoding.org/> (Accessed 30 November 2016)

ICOMOS: Principles for the Recording of Monuments, Groups of Buildings and Sites (1996). Available at: <http://www.icomos.org/charters/archives-e.pdf> (Accessed 30 November 2016)

IndoorGML: <http://www.opengeospatial.org/standards/indoorgml> (Accessed 27 December 2016)

SNAP:DRGN Cook Book: http://snapdrgn.net/wp-content/uploads/2014/01/SNAPDRGNCookbook_1.01.pdf (Accessed 29 December 2016)

Pleiades Gazetteer of Ancient Places: <https://pleiades.stoa.org/> (Accessed 31 December 2016)

i.Sicily Project. Building a digital corpus of Sicilian inscriptions: <https://isicily.wordpress.com/> (Accessed 31 December 2016)

Heritage Gazetteer of Cyprus: <http://www.cyprusgazetteer.org/> (Accessed 31 December 2016)

Heritage Gazetteer of Libya: <http://www.sls gazetteer.org/> (Accessed 31 December 2016)

List of Images and their bibliographical references

1. Piranesi G. B. (illustrator), Piranesi, F. (etcher). (1806) *Coupes en long et en travers du Temple d'Isis à Pompeia, et de ses parties adjacentes, de proportion double du plan gravé dans la Pl. precedete. Les parties indiquées en clair-obscur sont celles existantes. Les parties gravées au trait sont celles qu'on a supplées. Paris.* In Piranesi F., *Antiquités de la Grande Grèce aujourd'hui Royaume de Naples...*, Piranesi frères, 1804 - 1807, vol. II, Tav. L

2. Desprez, J.L. (illustrator) & Berthault, P.G. (etcher), *Vue du temple d'Isis a Pompeii prise sur la partie laterale et retabli tel qu'il devoit etre avant l'Eruption de 79.* In Saint Non (abbé de) J., *Voyage pittoresque ou description des royaumes de Naples et de Sicile. Seconde partie du premier volume...* Les Antiquités de Pompéii, Clousier, 1782, vol. I, Tav. 75

3. Desprez, J.L. (illustrator) & Dagoly fils (etchers) *Temple d'Isis à Pompeii tel qu'il devoit être en l'Année 79. lorsqu'il a été détruit par l'éruption du Vesuve; et rétabli d'après et suivant ce qui en existe encore aujourd'hui.* In Saint Non (abbé de) J., *Voyage pittoresque ou description des royaumes de Naples et de Sicile. Seconde partie du premier volume...* Les Antiquités de Pompéii, Clousier, 1782, vol. I, Tav. 75 bis

4. Piranesi G. B. (illustrator), Piranesi, F. (etcher). *Aspect du Temple d'Isis dont la démonstration géométrique à été supplée dans toutes les parties qui sont gravées au trait, ayant indiqué en clair-obscur les parties existantes.* In Piranesi F., *Antiquités de la Grande Grèce aujourd'hui Royaume de Naples...*, Piranesi frères, 1804 - 1807, vol. II, Tav. LXIX

5. and 6. Mazois, F (illustrator) & Bigant (etcher). *Tempio di Iside, decorazione architettonica, stucchi - prospetti.* In Mazois F., *Les Ruines de Pompéi, dessinées et mesurées par F. Mazois, pendant les années MDCCCIX, MDCCCX, MDCCCXI...* (ouvrage continué par M. Gau), Parigi, 1812 - 1838, vol. IV, Tav. XI and X

7. Leroux, L. H. *Ceremony in the Temple of Isis.* Published in Pompei e L'Europa 1748-1943. Electa 2015. Digital copy for non commercial purposes.

8. Piranesi G. B. (illustrator), Piranesi, F. (etcher). (1806) *Démonstrations géométriques de la porte de l'enceinte du temple d'Isis, avec ses valves ou battans de bois à trois parties qui la fermaient.* In: Piranesi F., *Antiquités de la Grande Grèce aujourd'hui Royaume de Naples...*, Piranesi frères, 1804 - 1807, vol. II, Tav. LXII

9. Mau, A. 1899. *Part of the Façade of the Purgatorium.* In *Pompeii: its life and art.* London : Macmillan & Co.

10. La Vega, F. 1764-6. *Elevation and cross section of the Iseum.* Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. *Pompei pitture e mosaici.* Roma : Istituto della enciclopedia italiana.

11. La Vega, F. (illustrator), Nolli, C. (etcher). *Purgatorium.* Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. *Pompei pitture e mosaici.* Roma : Istituto della enciclopedia italiana.

12. La Vega, F. (illustrator), Nolli, C. (etcher). *Purgatorium, particolari.* Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. *Pompei pitture e mosaici.* Roma : Istituto della enciclopedia italiana.

13. Mazois, F. (illustrator) & Dormier A.C (etcher) *Tempio di Iside - prospetto, sezione*. In: Mazois F., *Les Ruines de Pompéi, dessinées et mesurées par F. Mazois, pendant les années MDCCCIX, MDCCCX, MDCCCXI...* (ouvrage continué par M. Gau), Parigi, 1812 - 1838, vol. IV, Tav. IX
14. Hardwick, T., (1778) *Measured drawings of the Temple of Isis, Pompeii: sections*. RIBA Collections
15. Casanova, G. (illustrator) & A. Cattaneo (etcher), *Portico Ovest*. in Avellino, F. M. 1851. Il Tempio di Iside. Napoli. Published in Elia, O. 1941. Le pitture del Tempio di Iside. Roma.
16. Casanova, G. (illustrator) & A. Cattaneo (etcher), *Portico Est*. in Avellino, F. M. 1851. Il Tempio di Iside. Napoli. Published in Elia, O. 1941. Le pitture del Tempio di Iside. Roma.
17. Casanova, G. (illustrator) & A. Cattaneo (etcher), *Portico Nord*. in Avellino, F. M. 1851. Il Tempio di Iside. Napoli. Published in De Caro, S. (ed) 1992. *Alla ricerca di Iside : analisi, studi e restauri dell'Iseo pompeiano nel Museo di Napoli*.
18. Casanova, G. (illustrator) & A. Cattaneo (etcher), *Portico Sud*. in Avellino, F. M. 1851. Il Tempio di Iside. Napoli. Published in De Caro, S. (ed) 1992. *Alla ricerca di Iside : analisi, studi e restauri dell'Iseo pompeiano nel Museo di Napoli*.
19. Chiantarelli, G. (illustrator) & A. Cattaneo (etcher) *South wall of the ekklesiasterion in the Temple of Isis in Pompeii*. Published in Elia, O. 1941. Le pitture del Tempio di Iside. Roma.
20. Morghen, G. (illustrator) & A. Casanova (etcher) *North wall of the ekklesiasterion in the Temple of Isis in Pompeii*. Published in Elia, O. 1941. Le pitture del Tempio di Iside. Roma.
21. Chiantarelli, G. (illustrator) & A. Cattaneo (etcher) *West wall of the ekklesiasterion in the Temple of Isis in Pompeii*. Published in Elia, O. 1941. Le pitture del Tempio di Iside. Roma.
22. La Vega, F. (illustrator), Nolli, C. (etcher). *Pronao. Pianta e Prospetto*. Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. *Pompei pitture e mosaici*. Roma : Istituto della enciclopedia italiana.
23. La Vega, F. (illustrator), Nolli, C. (etcher). *Purgatorium, facciate est e ovest*. Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. *Pompei pitture e mosaici*. Roma : Istituto della enciclopedia italiana.
24. Bouchet, J. (1826). *Pianta, sezione, alzato del Tempio di Iside*. In *Pompei e gli architetti francesi dell'Ottocento*. Ecole Française de Rome 1981.
25. Callet, F. E. *Veduta del Tempio di Iside*. In *Pompei e gli architetti francesi dell'Ottocento*. Ecole Française de Rome 1981.
26. Durban, F. 1823-28. *Due sezioni del Tempio di Iside*. In *Pompei e gli architetti francesi dell'Ottocento*. Ecole Française de Rome 1981.
27. Bazzani, L. (1918). *Il tempio di Iside a Pompei*. Watercolour.
28. Fabris, P. (1776) *Lo scavo del tempio di Iside*. In Hamilton, W. *Campi Phlegreaei*, 1776, tav. XLI

29. Enslen, C.G. (1826) *Theatre and Temple of Isis at Pompeii*.
30. Cooke, G. (1819) *Pompeii Excavation of the Quarter of the Theatres etc*. Published in Gell, W. (1821) *Pompeiana : the topography, edifices, and ornaments of Pompeii*. Rodwell & Martin, New Bond Street
31. Woods, J (after Sharp, R.H.) *Temple of Isis, Pompeii. XIX century*. RIBA collection.
32. Wilkins, H. (illustrator) & Caracciolo, L. (etcher) *Temple d'Isis*. In Wilkins H., Suite de vues pittoresques des ruines de Pompeii et un precis historique de la ville avec un plan des fouilles qui ont été faites jusqu'en Février 1819 et une description des objects les plus intéressants, Roma, 1819, Tav. XXIV
33. Wilkins, H. Pencil and watercolour drawing of the Temple of Isis. In Originalaquarelle zu: Wilkins, Suite de vues pittoresques des ruines de Pompeii et un precis historique de la ville..., Tav. XXIV
34. Anonymous. *Vue du Temple d'Iside à Pompei (Dessiné d'après nature)* In: Voyage pittoresque, historique, et géographique de Rome à Naples et leurs environs, Napoli, 1823 - 1824, P. 56
35. Desprez, J.L. (illustrator) & Piranesi, F. (etcher). *Tempio di Iside, Purgatorium - veduta*. In: Piranesi F., Topografia delle fabbriche scoperte nella Città di Pompei, s.l., circa 1836, Tav. 1
36. Piranesi, G.B. (1772-8) *The Temple of Isis in Pompeii seen from the rear*. Pen and brown ink, over black chalk. British Museum Collection.
37. Piranesi, F. (illustrator and etcher). *Niche dans le temple d'Isis, à Pompeia*. In: Piranesi F., Antiquités de la Grande Grèce aujourd'hui Royaume de Naples..., Piranesi frères, 1804 - 1807, vol. III, Tav. I
38. Cockburn (Illustrator) & Cooke, W.B. (Etcher). *Niche in the Temple of Isis (1827)*. In: Cooke, W. B., Pompeii, illustrated with picturesque views, engraved by W. B. Cooke, from the original drawings of lieu. col. Cockburn ... and with plans and details of the public and domestic edifices, including the recent excavations, and a descriptive letterpress to each plate, by T. L. Donaldson, architect ... in two volumes. Vol. I. London, 1827.
39. Gusman, P. (1900) *Interior of the Megarum, Temple of Isis*. In Gusman, P. , Pompei, the city, its life & art. London 1900.
40. Chiantarelli, G. *South wall of the ekklesiasterion in the Temple of Isis in Pompeii*. Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. Pompei pitture e mosaici. Roma : Istituto della enciclopedia italiana. Digital copy for non commercial purposes.
41. Niccolini F, (1854). *In Le case ed i monumenti di Pompei: Volume Primo*. Napoli. (Tav. VIII).
42. Esposito, View of the Temple of Isis. Circa 1890.
43. Sommer, G. Tempio d'Iside Circa 1870.

44. Fragment 1.66. Museum of Naples. Temple of Isis Collection. Ekklesiasterion. *Sacred fence with temples, statues, and square with trees, seen through an architectural scene*. Left area of the west wall. Photograph of the author (2012).
45. Fragment 1.67. Museum of Naples. Temple of Isis Collection. Ekklesiasterion. *Landscape with sacred door and velum*. Right area of the west wall. Photograph of the author (2012).
46. Fragment 1.62. Museum of Naples. Temple of Isis Collection. Ekklesiasterion. *Landscape with ceremony in honour of Osiris*. Left area of the south wall. Photograph of the author (2012).
47. Jean Claude Richard's plan for the Temple of Isis in Pompeii. Voyage Pittoresque ou Description des Royaumes De Naples Et De Sicile, 1782.
48. John Soane's plan and front elevation for the Temple of Isis in Pompeii. Courtesy of the Soane Museum in London. Reproduced for non commercial purposes.
49. Piranesi's plan for the Temple of Isis in Pompeii. Table du second Volume des antiquités de Pompeia.
50. Scale model of the Iseum exhibited in the Museo Archeologico Nazionale di Napoli. Photograph by the author (2012).
51. Marble threshold of the Temple of Isis. Photograph by the author (2014)
52. Digital comparison (at reduced opacity) between the plans of the Iseum by Piranesi and Soane.
53. Digital comparison (at reduced opacity) between the plans of the Iseum by Saint-Non and Soane.
54. Detail of the fresco in the garden of the House of Orpheus in Pompeii. Photograph by the author (2014).
55. Niccolini, F. (1854). In *Le Case ed i Monumenti di Pompei: disegnati e descritti*. Napoli.
56. Presuhn, E. (1878) In *Les Décorations Murales de Pompéi*. Leipzig.
57. Mosaic of a dog. Found in the House of Orpheus in Pompeii. Photograph by the author (2012)
58. Plaster cast of a dog. Found in the House of Orpheus in Pompeii. Photograph taken in the British Museum during the exhibition *Life and Death in Pompeii and Herculaneum* (London 2013).
60. Expected placement of the mosaic of a dog in the context of the House of Orpheus, compared to its actual placement, according to Della Corte's records. Edited detail of the plan of Pompeii by Van der Pöhl.
61. Funerary relief of Vivius Marcius in the Ashmolean museum, and a selection of its copies. From left to right, top to down: Prideaux (1676), Gale (1709), Allen (1827), Knight (1841), Archer (1852).

62. Balzeby, M. Hypothetical restoration of a fresco in the Villa of Oplontis showing different degrees of certainty.

63. Borra, D. 3D visualisation of the villa of the Emperor Trajan in the Aniene Valley.

64. Ternite, W. (1858) *Sitzende Muse*. Wandgemälde aus Pompeji und Herculaneum nach den Zeichnungen und Nchbildungen in Farben : von W. Ternite ; mit einem erläuternden text von C. O. Müller. Berlin.

65. Ternite, W. (1858) *Quellorakel*. Wandgemälde aus Pompeji und Herculaneum nach den Zeichnungen und Nchbildungen in Farben : von W. Ternite ; mit einem erläuternden text von C. O. Müller. Berlin.

66. Hercules and Telephus. Detail of a fresco found in the basilica of Herculaneum.

67. Montagny E-H. (1804 circa) *Hercules and Telephus*. Sketch from Montagny E-H. (1804-5) *Recueil d'antiquités dessinée d'après des peintures trouvée a Herculaneum, Stabia et Pompeia qui sont maintenant au Musee de Portici a quatre milles de Naples*. Getty Research Institute.

68. Unknown artist after an etching by Charles-Nicolas Cochin the younger, draughtsman and engraver, 1715-1790. *Hercules and Telephus*. No. IV. of *Curiosities found in the Ruins of HERCULANEUM*.

Images that have been used as sources for the textures in the IseumGT visualisation

1. Casanova, G. (illustrator) & A. Cattaneo (etcher), Portico Ovest. in Avellino, F. M. 1851. *Il Tempio di Iside*. Napoli. Published in Elia, O. 1941. *Le pitture del Tempio di Iside*. Roma.

2. Casanova, G. (illustrator) & A. Cattaneo (etcher), Portico Est. in Avellino, F. M. 1851. *Il Tempio di Iside*. Napoli. Published in De Caro, S. (ed) 1992. *Alla ricerca di Iside : analisi, studi e restauri dell'Iseo pompeiano nel Museo di Napoli*.

3. Casanova, G. (illustrator) & A. Cattaneo (etcher), Portico Nord. in Avellino, F. M. 1851. *Il Tempio di Iside*. Napoli. Published in De Caro, S. (ed) 1992. *Alla ricerca di Iside : analisi, studi e restauri dell'Iseo pompeiano nel Museo di Napoli*.

4. Casanova, G. (illustrator) & A. Cattaneo (etcher), Portico Sud. in Avellino, F. M. 1851. *Il Tempio di Iside*. Napoli. Published in De Caro, S. (ed) 1992. *Alla ricerca di Iside : analisi, studi e restauri dell'Iseo pompeiano nel Museo di Napoli*.

5. Chiantarelli, G. (illustrator) & A. Cattaneo (etcher), South wall of the ekklesiasterion in the Temple of Isis in Pompeii. Published in Elia, O. 1941. *Le pitture del Tempio di Iside*. Roma.

6. Morghen, G. (illustrator) & A. Casanova (etcher) *North wall of the ekklesiasterion in the Temple of Isis in Pompeii*. Published in Elia, O. 1941. *Le pitture del Tempio di Iside*. Roma.

7. Chiantarelli, G. (illustrator) & A. Cattaneo (etcher) *West wall of the ekklesiasterion in the Temple of Isis in Pompeii*. Published in Elia, O. 1941. *Le pitture del Tempio di Iside*. Roma.

8. La Vega, F. (illustrator), Nolli, C. (etcher). *Pronao. Pianta e Prospetto*. Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. *Pompei pitture e mosaici*. Roma : Istituto della enciclopedia italiana.
9. La Vega, F. (illustrator), Nolli, C. (etcher). *Purgatorium, facciate est e ovest*. Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. *Pompei pitture e mosaici*. Roma : Istituto della enciclopedia italiana.
10. Mau, A. 1899. *Part of the Façade of the Purgatorium*. In *Pompeii: its life and art*. London : Macmillan & Co.
11. Piranesi G. B. (illustrator), Piranesi, F. (etcher). (1806) *Démonstrations géométriques de la porte de l'enceinte du temple d'Isis, avec ses valves ou battans de bois à trois parties qui la fermaient*. In: Piranesi F., *Antiquités de la Grande Grèce aujourd'hui Royaume de Naples...*, Piranesi frères, 1804 - 1807, vol. II, Tav. LXII

List of selected textual sources

1. Engelmann, R. & Talfourd, E. 1904. *Pompeii*. London: H. Grevel; New York: Scribner.
2. Mackenzie, W. M. & Pisa, A. 1910. *Pompeii*. London, A. & C. Black.
3. Dyer, T. H. 1870. *Pompeii. Its history, buildings and antiquities*. New York: Scribner, Welford, & Co.
4. Gell, W. 1852. *Pompeiana, the topography, edifices and ornaments of Pompeii*. H.G. Bohn, London
5. Lytton, E. Bulwer. 1873. *The destruction of Pompeii*. Boston
6. Clarke, G. & Clarke, W. 1847. *Pompeii : its destruction and re-discovery: from various sources*. London: C. Cox
7. Scotti, N. & Caprani, A. G. 1907. *Three hours in Pompeii; a real and practical guide-book compiled in harmony with description given by Bulwer Lytton in his work entitled "The last days of Pompeii"*. Naples
8. Fischetti, L. & Lauro, E. 1884. *Pompeii, past and present : illustrated by photographs of the ruins as they are, with sketches of their original elevations*. London : W. Clowes.
9. Clarke, W. 1847. *Pompeii : its past and present state, its public and private buildings, etc*. London: Nattali
10. Davenport, W. H., 1872. *The buried cities of Campania : or, Pompeii and Herculaneum, their history, their destruction, and their remains*. London: Nelson and sons.
11. Neville Rolfe, E. 1888. *Pompeii popular and practical : an easy book on a difficult subject*. Naples: Furchheim.
12. Weichardt, C., 1898. *Pompeii before its destruction : reconstruction of its temples and their surroundings*. Leipzig : K. F. Koehler
13. Monnier, C. 1871. *The Wonders of Pompeii. Translated from the original French*. New York: Scribner & Co.
14. De Jorio, A. 1836. Guida di Pompei. Napoli.
15. Rossini, L. 1831. Le Antichità di Pompei delineate sulle scoperte fatte sino a tutto l'anno MDCCCXXX dall'architetto Luigi Rossini Ravennate. Roma.
16. Gray, T. 1830. *The vestal; or, A tale of Pompeii*. Boston: Gray and Bowen
17. De Nerval, G., 1906. *Isis. Les filles du feu*.
18. Lytton, E.B.L.B., 1834. *The last days of Pompeii*. Wallis & Newell.

19. Hamilton, W. 1777. *Account of the discoveries at Pompeii : communicated to the Society of Antiquaries of London*. London: W. Bowyer and J. Nichols

Appendix A. List of spatial elements in the Iseum, according to the SCaT naming convention

SCOTCH URI: **SpaceA**

Label: Portico

SCOTCH description: Space A

3D representations: SpaceA_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003400004>

SpaceA_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31209157480>

SCOTCH URI: **SpA_CoE**

Label: East wall of the portico

SCOTCH description: East constraint of space A

3D representations: SpA_CoE_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034089343>

SpA_CoE_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31434882692>

SCOTCH URI: **SpA_CoE_F01**

Label: Small, rectangular niche in the east wall of the portico

SCOTCH description: First feature of the east constraint of space A

3D representations: SpA_CoE_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034089223>

SpA_CoE_F01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31434882692>

SCOTCH URI: **SpA_CoS**

Label: South wall of the portico

SCOTCH description: South constraint of space A

3D representations: SpA_CoS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034088753>

SpA_CoS_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31581362515>

SCOTCH URI: **SpA_CoS_F01**

Label: Large, rectangular niche in the south wall of the portico

SCOTCH description: First feature of the south constraint of space A

3D representations: SpA_CoS_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034088593>

SpA_CoS_F01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31581365785>

SCOTCH URI: **SpA_CoW**

Label: West wall of the portico

SCOTCH description: West constraint of space A

3D representations: SpA_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003406624>

SpA_CoW_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31434867272>

SCOTCH URI: **SpA_CoN**

Label: North wall of the portico

SCOTCH description: North constraint of space A

3D representations: SpA_CoN_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034089043>

SpA_CoN_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/30771552633/>

SCOTCH URI: **SpA_CoN_F01**

Label: Small, rectangular niche in the north wall of the portico

SCOTCH description: First feature of the north constraint of space A

3D representations: SpA_CoN_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034088933>

SpA_CoN_F01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31209179950>

SCOTCH URI: **SpA_F01**

Label: First column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: First feature of space A

3D representations: SpA_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003406524>

SpA_F01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31930191586>

SCOTCH URI: **SpA_F02**

Label: Second column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Second feature of space A

3D representations: SpA_F02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31818578532>

SpA_F02_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31930190886>

SCOTCH URI: **SpA_F03**

Label: Third column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Third feature of space A

3D representations: SpA_F03_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31929457096>

SpA_F03_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31157817263>

SCOTCH URI: **SpA_F04**

Label: Fourth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Fourth feature of space A

3D representations: SpA_F04_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31157019643>

SpA_F04_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31930189666>

SCOTCH URI: **SpA_F05**

Label: Fifth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Fifth feature of space A

3D representations: SpA_F05_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31126293714>

SpA_F05_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31157816423>

SCOTCH URI: **SpA_F06**

Label: Sixth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Sixth feature of space A

3D representations: SpA_F06_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31929455836>
SpA_F06_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31930188196>

SCOTCH URI: SpA_F07

Label: Seventh column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Seventh feature of space A

3D representations: SpA_F07_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31157017663>

SpA_F07_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31157814533/>

SCOTCH URI: SpA_F08

Label: Eight column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Eight feature of space A

3D representations: SpA_F08_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31592685530>

SpA_F08_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31930187076>

SCOTCH URI: SpA_F09

Label: Ninth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Ninth feature of space A

3D representations: SpA_F09_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31157016413>

SpA_F09_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31127082304>

SCOTCH URI: SpA_F10

Label: Tenth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Tenth feature of space A

3D representations: SpA_F10_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31592682870>

SpA_F10_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31930185386>

SCOTCH URI: SpA_F11

Label: Eleventh column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Eleventh feature of space A

3D representations: SpA_F11_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31157015463>

SpA_F11_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31127081584>

SCOTCH URI: SpA_F12

Label: Twelfth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Twelfth feature of space A

3D representations: SpA_F12_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31592680410>

SpA_F12_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31850505061>

SCOTCH URI: SpA_F13

Label: Thirteenth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Thirteenth feature of space A

3D representations: SpA_F13_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31818576102>

SpA_F13_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31581340865>

SCOTCH URI: **SpA_F14**

Label: Fourteenth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Fourteenth feature of space A

3D representations: SpA_F14_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31157014123>

SpA_F14_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31127080924>

SCOTCH URI: **SpA_F15**

Label: Fifteenth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Fifteenth feature of space A

3D representations: SpA_F15_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31592677450>

SpA_F15_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31850504401>

SCOTCH URI: **SpA_F16**

Label: Sixteenth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Sixteenth feature of space A

3D representations: SpA_F16_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31592676500>

SpA_F16_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31127080044>

SCOTCH URI: **SpA_F17**

Label: Seventeenth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Seventeenth feature of space A

3D representations: SpA_F17_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31929450056>

SpA_F17_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967022395>

SCOTCH URI: **SpA_F18**

Label: Eighteenth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Eighteenth feature of space A

3D representations: SpA_F18_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31929449276>

SpA_F18_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31127079064>

SCOTCH URI: **SpA_F19**

Label: Nineteenth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Nineteenth feature of space A

3D representations: SpA_F19_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966238085>

SpA_F19_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967021345>

SCOTCH URI: SpA_F20

Label: Twentieth column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Twentieth feature of space A

3D representations: SpA_F20_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31592673020>

SpA_F20_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31127077734>

SCOTCH URI: SpA_F21

Label: Twenty-first column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Twenty-first feature of space A

3D representations: SpA_F21_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966236205>

SpA_F21_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31127077104>

SCOTCH URI: SpA_F22

Label: Twenty-second column of the portico (counting clockwise, from the north-east corner of the colonnade)

SCOTCH description: Twenty-second feature of space A

3D representations: SpA_F22_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31592670890>

SpA_F22_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31127076534>

SCOTCH URI: SpA_F23

Label: North pillar with engaged column

SCOTCH description: Twenty-third feature of space A

3D representations: SpA_F23_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31929444496>

SpA_F23_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31930177736>

SCOTCH URI: SpA_F24

Label: South pillar with engaged column

SCOTCH description: Twenty-fourth feature of space A

3D representations: SpA_F24_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31929443496>

SpA_F24_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31930177076>

SCOTCH URI: SpA_F25

Label: South altar, on the side of the main temple

SCOTCH description: Twenty-fifth feature of space A

3D representations: SpA_F25_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31929442636>

SpA_F25_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31581330835>

SCOTCH URI: SpA_F26

Label: North altar, on the side of the main temple

SCOTCH description: Twenty-sixth feature of space A

3D representations: SpA_F26_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966230575>

SpA_F26_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31930176836/>

SCOTCH URI: **SpA_F27**

Label: Small feature, on the left of the staircase to the main temple

SCOTCH description: Twenty-seventh feature of space A

3D representations: SpA_F27_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003404954>

SpA_F27_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31581337955>

SCOTCH URI: **SpA_F28**

Label: Small north feature, on the right of the staircase to the main temple

SCOTCH description: Twenty-eight feature of space A

3D representations: SpA_F28_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003403994>

SpA_F28_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31581335915>

SCOTCH URI: **SpA_F29**

Label: Larger altar in front of the Purgatorium

SCOTCH description: Twenty-ninth feature of space A

3D representations: SpA_F29_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31843971285>

SpA_F29_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31434860442>

SCOTCH URI: **SpA_F30**

Label: Small built structure around a pit

SCOTCH description: Thirty first feature of space A

3D representations: SpA_F31_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31209159640>

SCOTCH URI: **SpA_CoU**

Label: Covering of the portico

SCOTCH description: Upper constraint of space A

3D representations: SpA_F29_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034089753>

SCOTCH URI: **SpA_CoU_F01**

Label: Architrave of the portico' roof

SCOTCH description: First feature of the upper constraint of space A

3D representations: SpA_CoU_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034088383>

SCOTCH URI: **SpA_CoU_F02**

Label: Architrave of the decorative element of the portico' roof

SCOTCH description: Second feature of the upper constraint of space A

3D representations: SpA_CoU_F02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034088243>

SCOTCH URI: **SpA_CoU_F03**

Label: Tiling of the portico' roof

SCOTCH description: Third feature of the upper constraint of space A

3D representations: SpA_CoU_F03_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003407444>

SCOTCH URI: **SpA_CoU_F04**

Label: Decorative row of tiles on top of the portico walls

SCOTCH description: Fourth feature of the upper constraint of space A
3D representations: SpA_CoU_F04_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034087853>

SCOTCH URI: **SpA_CoU_F05**

Label: Tiling of the decorative element of the portico' roof
SCOTCH description: Fifth feature of the upper constraint of space A
3D representations: SpA_CoU_F05_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003407074>

SCOTCH URI: **SpA_CoU_F06**

Label: East pediment of the decorative element of the portico' roof
SCOTCH description: Sixth feature of the upper constraint of space A
3D representations: SpA_CoU_F06_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034087633>

SCOTCH URI: **SpA_CoU_F07**

Label: West pediment of the decorative element of the portico' roof
SCOTCH description: Seventh feature of the upper constraint of space A
3D representations: SpA_CoU_F07_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034087553>

SCOTCH URI: **SpaceC**

Label: Temple of Isis
SCOTCH description: Space C
3D representations: SpaceC_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034081993>
SpaceC_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31543669806>

SCOTCH URI: **SpC_CoD**

Label: Podium of the main temple
SCOTCH description: Down constraint of Space C
3D representations: SpC_CoD_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696688512/in/album-72157678130760216/>
SpC_CoD_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31434797562>

SCOTCH URI: **SpC_CoW**

Label: West wall of the main temple
SCOTCH description: west constraint of space C
3D representations: SpC_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966215435>
SpC_CoW_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31581263925>

SCOTCH URI: **SpC_CoN**

Label: North wall of the main temple
SCOTCH description: north constraint of space C
3D representations: SpC_CoN_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31592651860>
SpC_CoN_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31434785932>

SCOTCH URI: **SpC_CoS**

Label: South wall of the main temple
SCOTCH description: south constraint of space C

3D representations: SpC_CoS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31849827541>
SpC_CoS_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31465319861>

SCOTCH URI: SpC_F01

Label: North niche on the side of the main temple

SCOTCH description: first feature of space C

3D representations: SpC_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31156995563>

SpC_F01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31465315671>

SCOTCH URI: SpC_F02

Label: South niche on the side of the main temple

SCOTCH description: second feature of space C

3D representations: SpC_F02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966213735>

SpC_F02_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31581259145>

SCOTCH URI: SpC_CoU

Label: Covering of the main temple

SCOTCH description: upper constraint of space C

3D representations: SpC_CoU_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003396844/>

SCOTCH URI: SpC_CoU_F01

Label: Architrave of the roof of the main temple

SCOTCH description: first feature of the upper constraint of space C

3D representations: SpC_CoU_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034080763>

SCOTCH URI: SpC_CoU_F02

Label: Tiling of the roof of the main temple

SCOTCH description: second feature of the upper constraint of space C

3D representations: SpC_CoU_F02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003396424>

SCOTCH URI: SpC_CoU_F03

Label: East pediment of the roof of the main temple

SCOTCH description: third feature of the upper constraint of space C

3D representations: SpC_CoU_F03_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003396124>

SCOTCH URI: SpC_CoU_F04

Label: West pediment of the roof of the main temple

SCOTCH description: fourth feature of the upper constraint of space C

3D representations: SpC_CoU_F04_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003395854>

SCOTCH URI: SpaceH

Label: Pronaos of the main temple

SCOTCH description: Space H

3D representations: SpaceH.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31034081463>

SpaceH.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/30771501333>

SCOTCH URI: **SpH_CoW**

Label: Front wall of the main temple

SCOTCH description: west constraint of space H

3D representations: SpH_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31843962595>

SpH_CoW_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31434735512>

SCOTCH URI: **SpH_CoS_F01**

Label: Column on the pronaos of the main temple

SCOTCH description: first feature of the south constrain of Space H

3D representations: SpH_CoS_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31156991363>

SpH_CoS_F01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31581222885>

SCOTCH URI: **SpH_CoS_F02**

Label: Column on the pronaos of the main temple

SCOTCH description: second feature of the south constrain of Space H

3D representations: SpH_CoS_F02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31156991313>

SpH_CoS_F02_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31434737372>

SCOTCH URI: **SpH_CoE_F01**

Label: Column on the pronaos of the main temple

SCOTCH description: first feature of the east constraint of Space H

3D representations: SpH_CoE_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966212945>

SpH_CoE_F01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31465273891>

SCOTCH URI: **SpH_CoE_F02**

Label: Column on the pronaos of the main temple

SCOTCH description: second feature of the east constraint of Space H

3D representations: SpH_CoE_F02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966212725>

SpH_CoE_F02_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31543577916>

SCOTCH URI: **SpH_CoN_F01**

Label: Column on the pronaos of the main temple

SCOTCH description: first feature of the north constrain of Space H

3D representations: SpH_CoN_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31156994213>

SpH_CoN_F01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31434742182>

SCOTCH URI: **SpH_CoN_F02**

Label: Column on the pronaos of the main temple

SCOTCH description: second feature of the north constrain of Space H

3D representations: SpH_CoN_F02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31156994183>
SpH_CoN_F02_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/30771424423>

SCOTCH URI: **Spacel**

Label: Cella of the main temple

SCOTCH description: Space I

3D representations: Spacel.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31966228585>

Spacel.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31581301535>

SCOTCH URI: **Spl_CoW**

Label: West wall of the inside of the temple

SCOTCH description: west constraint of Space I

3D representations: Spl_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966212585>

Spl_CoW_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31434721492>

SCOTCH URI: **Spl_CoE**

Label: East wall of the inside of the temple

SCOTCH description: east constraint of Space I

3D representations: Spl_CoE_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966210335>

Spl_CoE_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31581214815>

SCOTCH URI: **Spl_CoS**

Label: South wall of the inside of the temple

SCOTCH description: south constrain of Space I

3D representations: Spl_CoS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966207565>

Spl_CoS_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31581209715>

SCOTCH URI: **Spl_CoN**

Label: North wall of the inside of the temple

SCOTCH description: north constrain of Space I

3D representations: Spl_CoN_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966209215>

Spl_CoN_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31434727172>

SCOTCH URI: **SpaceJ**

Label: Cellar of the main temple

SCOTCH description: Space J

3D representations: SpaceJ.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31592653170>

SpaceJ.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31543631156/in>

SCOTCH URI: **SpJ_CoE**

Label: East wall of the cellar of the main temple

SCOTCH description: East constraint of Space J

3D representations: SpJ_CoE.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31966268415>

SpJ_CoE.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31209031810>

SCOTCH URI: **SpJ_CoU**

Label: Covering of the cellar of the main temple

SCOTCH description: Up constraint of Space J

3D representations: SpJ_CoU.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31966265685>

SpJ_CoU.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31543560486>

SCOTCH URI: **SpJ_CoU_F01**

Label: Vaulted ceiling of the cellar of the main temple

SCOTCH description: Feature of the Up constraint of Space J

3D representations: SpJ_CoU_F01.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31929476196>

SpJ_CoU_F01.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31543561256>

SCOTCH URI: **SpaceE**

Label: Ekklesiasterion

SCOTCH description: Space E

3D representations: SpaceE.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31963321856>

SpaceE.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31465366351>

SCOTCH URI: **SpE_CoW**

Label: West wall of the Ekklesiasterion

SCOTCH description: West constraint of Space E

3D representations: SpE_CoW.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31003393174>

SpE_CoW.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31209050690>

SCOTCH URI: **SpE_CoE**

Label: East wall of the Ekklesiasterion

SCOTCH description: East constraint of Space E

3D representations: SpE_CoE.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31034080303>

SpE_CoE.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31191223733>

SCOTCH URI: **SpE_CoS**

Label: South wall of the Ekklesiasterion

SCOTCH description: South constraint of Space E

3D representations: SpE_CoS.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31843964305>

SpE_CoS.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31465293171>

SCOTCH URI: **SpE_CoN**

Label: North wall of the Ekklesiasterion

SCOTCH description: North constraint of Space E

3D representations: SpE_CoN.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31696683312>

SpE_CoN.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/30771445923>

SCOTCH URI: **SpE_CoU**

Label: Roof of the Ekklesiasterion

SCOTCH description: Up constraint of Space E

3D representations: SpE_CoU.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31003393524>

SCOTCH URI: **SpE_CoU_F01**

Label: South pediment of the roof of the Ekklesiasterion

SCOTCH description: First feature of the Up constraint of Space E

3D representations: SpE_CoU_F01.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31696682792>

SCOTCH URI: **SpE_CoU_F02**

Label: Tiling of the roof of the Ekklesiasterion

SCOTCH description: Second feature of the Up constraint of Space E

3D representations: SpE_CoU_F02.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31003393314>

SCOTCH URI: **SpE_CoU_F03**

Label: North pediment of the roof of the Ekklesiasterion

SCOTCH description: Third feature of the Up constraint of Space E

3D representations: SpE_CoU_F03.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31696682512>

SCOTCH URI: **SpaceF**

Label: Sacrarium

SCOTCH description: Space F

3D representations: SpaceF_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31968816715>

SpaceF_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31595415160>

SCOTCH URI: **SpF_CoE**

Label: East wall of the sacrarium

SCOTCH description: east constrain of Space F

3D representations: SpF_CoE_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696682292>

SpF_CoE_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31969005035>

SCOTCH URI: **SpF_CoN**

Label: North wall of the sacrarium

SCOTCH description: north constrain of Space F

3D representations: SpF_CoN_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696682032>

SpF_CoN_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31821274612/>

SCOTCH URI: **SpaceT**

Label: Purgatorium

SCOTCH description: Space T

3D representations: SpaceT.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31034081083>

SpaceT.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/30740076084/in>

SCOTCH URI: **SpT_CoE**

Label: East wall of the Purgatorium

SCOTCH description: East constraint of Space T

3D representations: SpT_CoE.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31034073823>
SpT_CoE.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/30771396263>

SCOTCH URI: **SpT_CoW**

Label: West wall of the Purgatorium

SCOTCH description: West constraint of Space T

3D representations: SpT_CoW.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31696676892>

SpT_CoW.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31465238621>

SCOTCH URI: **SpT_CoS**

Label: South wall of the Purgatorium

SCOTCH description: South constraint of Space T

3D representations: SpT_CoS.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31592705570>

SpT_CoS.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31465244881>

SCOTCH URI: **SpT_CoN**

Label: North wall of the Purgatorium

SCOTCH description: North constraint of Space T

3D representations: SpT_CoN.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31696677582>

SpT_CoN.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/30771387723>

SCOTCH URI: **SpT_F01**

Label: Engaged column of the Purgatorium

SCOTCH description: First feature of of Space T

3D representations: SpT_F01.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31696676752>

SpT_F01.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31465230671>

SCOTCH URI: **SpT_F02**

Label: Engaged column of the Purgatorium

SCOTCH description: Second feature of of Space T

3D representations: SpT_F02.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31929458526/>

SpT_F02.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/30739938294/>

SCOTCH URI: **SpT_F03**

Label: Engaged column of the Purgatorium

SCOTCH description: Third feature of of Space T

3D representations: SpT_F03.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31929458466>

SpT_F03.3DS_GT available at <https://www.flickr.com/photos/134064462@N06/31821272532/>

SCOTCH URI: **SpT_F04**

Label: Engaged column of the Purgatorium

SCOTCH description: Fourth feature of of Space T

3D representations: SpT_F04.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31929458356>

SpT_F04.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/30771369103/>

SCOTCH URI: **SpT_F05**

Label: Engaged column of the Purgatorium

SCOTCH description: Fifth feature of of Space T

3D representations: SpT_F05.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31929458236>

SpT_F05.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31581135795/>

SCOTCH URI: **SpT_F06**

Label: Engaged column of the Purgatorium

SCOTCH description: Sixth feature of of Space T

3D representations: SpT_F06.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31929458176>

SpT_F06.3DS_GT available at <https://www.flickr.com/photos/134064462@N06/31852567361/>

SCOTCH URI: **SpT_CoU**

Label: Covering of the Purgatorium

SCOTCH description: Up constraint of Space T

3D representations: SpT_CoU.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31157026183>

SpT_CoU.3DS_GT available at <https://www.flickr.com/photos/134064462@N06/31969004845>

SCOTCH URI: **SpT_CoU_F01**

Label: North pediment of the roof of the Purgatorium

SCOTCH description: First feature of the Up constraint of Space T

3D representations: SpT_CoU_F01.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31034073153>

SpT_CoU_F01.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31581171045>

SCOTCH URI: **SpT_CoU_F02**

Label: South pediment of the roof of the Purgatorium

SCOTCH description: Second feature of the Up constraint of Space T

3D representations: SpT_CoU_F02.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31929459506>

SpT_CoU_F02.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/30771383303>

SCOTCH URI: **SpT_CoU_F03**

Label: Tiling of the roof of the Purgatorium

SCOTCH description: Third feature of the Up constraint of Space T

3D representations: SpT_CoU_F03.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31696677182>

SCOTCH URI: **SpT_CoU_F04**

Label: Small architrave of the Purgatorium

SCOTCH description: Fourth feature of the Up constraint of Space T

3D representations: SpT_CoU_F04.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31157028303>

SpT_CoU_F04.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31543526986>

SCOTCH URI: **SpaceM**

Label: Room on the ground floor of Purgatorium

SCOTCH description: Space M
3D representations: SpaceM.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31595175770>
SpaceM.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31434807132>

SCOTCH URI: **SpM_CoW**

Label: West wall in the ground floor room in the Purgatorium
SCOTCH description: West constraint of Space M
3D representations: SpM_CoW.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31929466826>
SpM_CoW.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/30739986564>

SCOTCH URI: **SpM_CoE**

Label: East wall in the ground floor room in the Purgatorium
SCOTCH description: East constraint of Space M
3D representations: SpE_CoE.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31966262535>
SpM_CoE.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31581196265>

SCOTCH URI: **SpM_CoN**

Label: North wall in the ground floor room in the Purgatorium
SCOTCH description: North constraint of Space M
3D representations: SpM_CoN.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31157037203>
SpM_CoN.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/31581194425>

SCOTCH URI: **SpM_CoS**

Label: South wall in the ground floor room in the Purgatorium
SCOTCH description: South constraint of Space M
3D representations: SpS_CoW.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31929468506>
SpM_CoS.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/30739989024/>

SCOTCH URI: **SpM_CoD**

Label: Pavement the ground floor room in the Purgatorium
SCOTCH description: Down constraint of Space M
3D representations: SpM_CoD.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31849858111>
SpM_CoD.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/30771412073>

SCOTCH URI: **SpM_F01**

Label: Small wall covering the stairs that lead to the underground level
SCOTCH description: Feature of Space M
3D representations: SpM_F01.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31929464606>
SpM_F01.3DS_GT available at: <https://www.flickr.com/photos/134064462@N06/30771399953>

SCOTCH URI: **SpaceU**

Label: Underground room of the Purgatorium
SCOTCH description: Space U
3D representations: SpaceU.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31696689582>

SCOTCH URI: **SpU_CoE**

Label: East wall of the underground room of the Purgatorium

SCOTCH description: East constraint of Space U

3D representations: SpU_CoE.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31696676652>

SCOTCH URI: **SpU_CoW**

Label: West wall of the underground room of the Purgatorium

SCOTCH description: West constraint of Space U

3D representations: SpU_CoW.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31034071833>

SCOTCH URI: **SpU_CoN**

Label: North wall of the underground room of the Purgatorium

SCOTCH description: North constraint of Space U

3D representations: SpU_CoN.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31696676472>

SCOTCH URI: **SpU_CoS**

Label: South wall of the underground room of the Purgatorium

SCOTCH description: South constraint of Space U

3D representations: SpU_CoS.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31696676312>

SCOTCH URI: **SpU_CoU**

Label: Vaulted ceiling of the underground room of the Purgatorium

SCOTCH description: Up constraint of Space U

3D representations: SpU_CoU.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31034071993>

SCOTCH URI: **SpU_CoD**

Label: Pavement of the underground room of the Purgatorium

SCOTCH description: Down constraint of Space U

3D representations: SpU_CoD.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31929457976>

SCOTCH URI: **SpU_F01**

Label: Small triangular step in the north-east corner of the underground room of the Purgatorium

SCOTCH description: First feature of Space U

3D representations: SpU_F01.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31034071623>

SCOTCH URI: **SpU_F02**

Label: Small wall protecting the tub in the underground room of the Purgatorium

SCOTCH description: Second feature of Space U

3D representations: SpU_F02.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31034071443>

SCOTCH URI: **SpU_F03**

Label: Small tub in the underground room of the Purgatorium

SCOTCH description: Third feature of Space U

3D representations: SpU_F03.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31696675462>

SCOTCH URI: **SpaceO**

Label: Private Rooms

SCOTCH description: Space O

3D representations: SpaceO_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31159552133>

SCOTCH URI: **SpO_CoW**

Label: West wall delimiting the complex of the private rooms

SCOTCH description: west constraint of Space O

3D representations: SpO_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31843962075>

SCOTCH URI: **SpO_CoS**

Label: South wall delimiting the complex of the private rooms

SCOTCH description: south constraint of Space O

3D representations: SpO_CoS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31843962255>

SCOTCH URI: **SpO_CoN**

Label: North wall delimiting the complex of the private rooms

SCOTCH description: north constraint of Space O

3D representations: SpO_CoN_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696681342/in/album-72157678130760216/>

SCOTCH URI: **SpO_CoU**

Label: Covering of the second story rooms

SCOTCH description: Up constraint of Space O

3D representations: SpO_CoU_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31128950274>

SCOTCH URI: **SpO_CoU_F01**

Label: Tiling of the roof covering the second story rooms

SCOTCH description: first feature of constraint up of Space O

3D representations: SpO_CoU_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31595163300>

SCOTCH URI: **SpO_CoU_F02**

Label: North pediment of the roof covering the second story rooms

SCOTCH description: second feature of constraint up of Space O

3D representations: SpO_CoU_F02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31128949264>

SCOTCH URI: **SpO_CoU_F03**

Label: South pediment of the roof covering the second story rooms

SCOTCH description: third feature of constraint up of Space O

3D representations: SpO_CoU_F03_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31821375622>

SCOTCH URI: **SpaceG**

Label: Kitchen

SCOTCH description: Space G
3D representations: SpaceG.3DS_79 available at: <https://www.flickr.com/photos/134064462@N06/31592663940>

SCOTCH URI: **SpG_CoN**

Label: North wall of the kitchen

SCOTCH description: north constrain of Space G

3D representations: SpG_CoN_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966213565>

SCOTCH URI: **SpG_CoS**

Label: South wall of the kitchen

SCOTCH description: south constrain of Space G

3D representations: SpG_CoS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31156995093>

SCOTCH URI: **SpG_CoW**

Label: West wall of the kitchen

SCOTCH description: west constrain of Space G

3D representations: SpG_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31966213265>

SCOTCH URI: **SpG_CoE**

Label: East wall of the kitchen

SCOTCH description: east constrain of Space G

3D representations: SpG_CoE_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31156995333>

SCOTCH URI: **SpG_CoU**

Label: Ceiling of the kitchen

SCOTCH description: up constrain of Space G

3D representations: SpG_CoU_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31156994913>

SCOTCH URI: **SpG_F01**

Label: Kitchen's oven

SCOTCH First feature of Space G

3D representations: SpG_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31156994663>

SCOTCH URI: **SpaceR**

Label: Triclinium

SCOTCH description: Space R

3D representations: SpaceR_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31595171980>

SCOTCH URI: **SpR_CoN**

Label: North wall of the triclinium

SCOTCH description: north constrain of Space R

3D representations: SpR_CoN_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31157028553>

SCOTCH URI: **SpR_CoS**

Label: South wall of the triclinium
SCOTCH description: south constrain of Space R
3D representations: SpR_CoS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31727681731>

SCOTCH URI: **SpR_CoW**
Label: West wall of the triclinium
SCOTCH description: west constrain of Space R
3D representations: SpR_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003391844>

SCOTCH URI: **SpR_CoE**
Label: East wall of the triclinium
SCOTCH description: east constrain of Space R
3D representations: SpR_CoE_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31843961205>

SCOTCH URI: **SpR_CoU**
Label: Ceiling of the triclinium
SCOTCH description: north constrain of Space R
3D representations: SpR_CoU_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696680042>

SCOTCH URI: **SpaceS**
Label: Cubiculum
SCOTCH description: Space S
3D representations: SpaceS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31595171890>

SCOTCH URI: **SpS_CoN**
Label: North wall of the cubiculum
SCOTCH description: north constrain of Space S
3D representations: SpS_CoN_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003391654>

SCOTCH URI: **SpS_CoS**
Label: South wall of the cubiculum
SCOTCH description: south constrain of Space S
3D representations: SpS_CoS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696678782>

SCOTCH URI: **SpS_CoW**
Label: West wall of the cubiculum
SCOTCH description: west constrain of Space S
3D representations: SpS_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034074043>

SCOTCH URI: **SpS_CoE**
Label: East wall of the cubiculum
SCOTCH description: east constrain of Space S
3D representations: SpS_CoE_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31003391774>

SCOTCH URI: **SpS_CoU_F01**

Label: Tiling of the cubiculum's roof

SCOTCH description: first feature of the up constrain of Space S

3D representations: SpS_CoU_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034074413>

SCOTCH URI: **SpS_CoU_F02**

Label: Supporting structure of the tiles in the cubiculum's roof

SCOTCH description: second feature of the up constrain of Space S

3D representations: SpS_CoU_F02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696678332>

SCOTCH URI: **SpaceP**

Label: Second storey room above the kitchen

SCOTCH description: Space P

3D representations: SpaceP_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31595172340>

SCOTCH URI: **SpP_CoW**

Label: West wall of the second story room above the kitchen

SCOTCH description: west constrain of Space P

3D representations: SpP_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967754475>

SCOTCH URI: **SpP_CoE**

Label: East wall of the second story room above the kitchen

SCOTCH description: east constrain of Space P

3D representations: SpP_CoE_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31158489573>

SCOTCH URI: **SpP_CoS**

Label: South wall of the second story room above the kitchen

SCOTCH description: south constrain of Space P

3D representations: SpP_CoS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31851241721>

SCOTCH URI: **SpP_CoN**

Label: North wall of the second story room above the kitchen

SCOTCH description: north constrain of Space P

3D representations: SpP_CoN_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967754675>

SCOTCH URI: **SpP_CoD**

Label: Pavement of the second story room above the kitchen

SCOTCH description: down constrain of Space P

3D representations: SpP_CoD_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31157029353>

SCOTCH URI: **SpP_CoU**

Label: Ceiling of the second story room above the kitchen

SCOTCH description: up constrain of Space P

3D representations: SpP_CoU_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31595162690>

SCOTCH URI: **SpaceQ**

Label: Second storey room above the triclinium

SCOTCH description: Space Q

3D representations: SpaceQ_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31595172170>

SCOTCH URI: **SpQ_CoE**

Label: East wall of the second story room above the triclinium

SCOTCH description: east constrain of Space Q

3D representations: SpQ_CoE_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31843961625>

SCOTCH URI: **SpQ_CoW**

Label: West wall of the second story room above the triclinium

SCOTCH description: west constrain of Space Q

3D representations: SpQ_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696680212>

SCOTCH URI: **SpQ_CoN**

Label: North wall of the second story room above the triclinium

SCOTCH description: north constrain of Space Q

3D representations: SpQ_CoN_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31843961445>

SCOTCH URI: **SpQ_CoS**

Label: South wall of the second story room above the triclinium

SCOTCH description: south constrain of Space Q

3D representations: SpQ_CoS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31128949014>

SCOTCH URI: **SpQ_CoD**

Label: Pavement of the second story room above the triclinium

SCOTCH description: down constrain of Space Q

3D representations: SpQ_CoD_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31843961885>

SCOTCH URI: **SpQ_CoU**

Label: Ceiling of the second story room above the triclinium

SCOTCH description: up constrain of Space Q

3D representations: SpQ_CoU_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31157028773>

SCOTCH URI: **SpaceY**

Label: U area at the back of the triclinium

SCOTCH description: Space Y

3D representations: SpaceY_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696689062>

SCOTCH URI: **SpY_CoN**

Label: North wall of the unidentified area at the back of the triclinium

SCOTCH description: north constrain of Space Y

3D representations: SpY_CoN_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034070943>

SCOTCH URI: SpY_CoS

Label: South wall of the unidentified area at the back of the triclinium

SCOTCH description: south constrain of Space Y

3D representations: SpY_CoS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696674762>

SCOTCH URI: SpY_CoE

Label: East wall of the unidentified area at the back of the triclinium

SCOTCH description: east constrain of Space Y

3D representations: SpY_CoE_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696675072>

SCOTCH URI: SpY_CoW

Label: West wall of the unidentified area at the back of the triclinium

SCOTCH description: west constrain of Space Y

3D representations: SpY_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034070673>

SCOTCH URI: SpaceV

Label: Unidentified area at the back of the kitchen

SCOTCH description: west constrain of Space V

3D representations: SpV_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31964152636>

SCOTCH URI: SpV_CoW

Label: West wall of the unidentified area at the back of the kitchen

SCOTCH description: west constrain of Space V

3D representations: SpV_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31627258620>

SCOTCH URI: SpV_CoS

Label: South wall of the unidentified area at the back of the kitchen

SCOTCH description: south constrain of Space V

3D representations: SpV_CoS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696675232/in/album-72157678130760216/>

SCOTCH URI: SpX_CoN

Label: North external wall delimiting the Iseum

SCOTCH description: north constraint of Space X

3D representations: SpX_CoN_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31968807815>

SpX_CoN_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31595409700>

SCOTCH URI: SpX_CoE

Label: East external wall delimiting the Iseum

SCOTCH description: east constraint of Space X

3D representations: SpX_CoE_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31595171440>

SpX_CoE_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31821258172>

SCOTCH URI: SpX_CoS

Label: South external wall delimiting the Iseum

SCOTCH description: north constraint of Space X
3D representations: SpX_CoS_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31821379412>
SpX_CoS_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31968999965>

SCOTCH URI: SpX_CoW

Label: West external wall delimiting the Iseum
SCOTCH description: west constraint of Space X
3D representations: SpX_CoW_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31821050252/>
SpX_CoW_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31821268622>

SCOTCH URI: TrA_to_E01

Label: First arch from the left, leading inside the ekklesiasterion
SCOTCH description: first transition between Space A to Space E
3D representations: TrA_to_E01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967753855>
TrA_to_E01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31128028804>

SCOTCH URI: TrA_to_E02

Label: Second arch from the left, leading inside the ekklesiasterion
SCOTCH description: second transition between Space A to Space E
3D representations: TrA_to_E02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967753775>
TrA_to_E02_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31851458591>

SCOTCH URI: TrA_to_E03

Label: Third arch from the left, leading inside the ekklesiasterion
SCOTCH description: third transition between Space A to Space E
3D representations: TrA_to_E03_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967753705>
TrA_to_E03_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31851458501>

SCOTCH URI: TrA_to_E04

Label: Fourth arch from the left, leading inside the ekklesiasterion
SCOTCH description: fourth transition between Space A to Space E
3D representations: TrA_to_E04_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967753585>
TrA_to_E04_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31851458381/in/album-72157677624226266/>

SCOTCH URI: TrA_to_E05

Label: Fifth arch from the left, leading inside the ekklesiasterion
SCOTCH description: Fifth transition between Space A to Space E
3D representations: TrA_to_E05_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967753475>
TrA_to_E05_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31851458281>

SCOTCH URI: TrA_to_F

Label: Archway leading inside the sacrum
SCOTCH description: transition between Space A to Space F
3D representations: TrA_to_F_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31158487863>
TrA_to_F_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31128028514>

SCOTCH URI: **TrH_to_I**
Label: Main entrance to the Temple of Isis
SCOTCH description: transition between Space H to Space I
3D representations: TrH_to_I_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31158487293>
TrH_to_I_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31128027914>

SCOTCH URI: **TrH_to_I_F01**
Label: Main door to the Temple of Isis
SCOTCH description: Feature of the transition between Space H to Space I
3D representations: TrH_to_I_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967752805/in/album-72157678130760216/>

SCOTCH URI: **TrA_to_I01**
Label: Stairs leading to the secondary entrance to the Temple of Isis
SCOTCH description: first transition between Space A to Space I
3D representations: TrA_to_I01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967753295>
TrA_to_I01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31851458091>

SCOTCH URI: **TrA_to_I02**
Label: Secondary entrance to the Temple of Isis
SCOTCH description: second transition between Space A to Space I
3D representations: TrA_to_I02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967752965>
TrA_to_I02_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31128028184>

SCOTCH URI: **TrA_to_C**
Label: Stairs leading to the main entrance to the Temple of Isis
SCOTCH description: transition between Space A to Space C
3D representations: TrA_to_C_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31819903592>
TrA_to_C_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31128026794>

SCOTCH URI: **TrA_to_C_F01**
Label: Right banister along the stairs leading to the main entrance to the Temple of Isis
SCOTCH description: first feature of the transition between Space A to Space C
3D representations: TrA_to_C_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31819903402>
TrA_to_C_F01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31851458911>

SCOTCH URI: **TrA_to_C_F02**
Label: Left banister along the stairs leading to the main entrance to the Temple of Isis
SCOTCH description: second feature of the transition between Space A to Space C
3D representations: TrA_to_C_F02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967753915>

TrA_to_C_F02_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31128028904>

SCOTCH URI: TrX_to_A01

Label: Main entrance to the Iseum

SCOTCH description: first transition between Space X to Space A

3D representations: TrX_to_A01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31158486943>

TrX_to_A01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31851457291>

SCOTCH URI: TrX_to_A02

Label: Secondary entrance to the Iseum

SCOTCH description: second transition between Space X to Space A

3D representations: TrX_to_A02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31159543163>

TrX_to_A02_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31821263322/>

SCOTCH URI: TrI_to_J01

Label: Left small entrance to the temple's cellar

SCOTCH description: first transition between Space I to Space J

3D representations: TrI_to_J01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967752595>

TrI_to_J01_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31851456161>

SCOTCH URI: TrI_to_J02

Label: Right small entrance to the temple's cellar

SCOTCH description: second transition between Space I to Space J

3D representations: TrI_to_J02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967752455>

TrI_to_J02_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31851456091>

SCOTCH URI: TrA_to_T

Label: Entrance to the Purgatorium

SCOTCH description: transition between Space A to Space T

3D representations: TrA_to_T_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31931987956>

TrA_to_T_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31129118774>

SCOTCH URI: TrA_to_T_F01

Label: Door to the Purgatorium

SCOTCH description: Feature of the transition between Space A to Space T

3D representations: TrA_to_T_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967752965>

SCOTCH URI: TrM_to_U01

Label: Stairs leading to the underground room of the Purgatorium

SCOTCH description: first transition between Space M to Space U

3D representations: TrM_to_U01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31471082500>

SCOTCH URI: TrM_to_U02

Label: Vaulted threshold leading to the underground room of the Purgatorium
SCOTCH description: second transition between Space M to Space U
3D representations: TrM_to_U02.3DS available at: <https://www.flickr.com/photos/134064462@N06/31967752315/in/album-72157678130760216/>

SCOTCH URI: TrA_to_S

Label: Entrance to the cubiculum
SCOTCH description: transition between Space A to Space S
3D representations: TrA_to_S_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696674272>
TrA_to_S_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31851457751>

SCOTCH URI: TrA_to_R

Label: Entrance to the triclinium
SCOTCH description: transition between Space A to Space R
3D representations: TrA_to_R_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31471083000>
TrA_to_R_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31851457861>

SCOTCH URI: TrA_to_G

Label: Entrance to the kitchen
SCOTCH description: transition between Space A to Space G
3D representations: TrA_to_G_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31034070413>
TrA_to_G_GT.3DS available at: <https://www.flickr.com/photos/134064462@N06/31128028394>

SCOTCH URI: TrG_to_R

Label: Connection between the kitchen and the triclinium
SCOTCH description: transition between Space G to Space R
3D representations: TrG_to_R_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31471082670>

SCOTCH URI: TrX_to_G

Label: Secondary entrance to the kitchen
SCOTCH description: transition between Space X to Space G
3D representations: TrX_to_G_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31471082100>

SCOTCH URI: TrP_to_Q

Label: Connection between the second storey rooms above the kitchen and the triclinium
SCOTCH description: transition between Space P to Space Q
3D representations: TrP_to_Q_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696674532>

SCOTCH URI: TrG_to_Y

Label: Connection between the kitchen and the unidentified space at its back
SCOTCH description: transition between Space G to Space Y
3D representations: TrG_to_Y_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696673992>

SCOTCH URI: TrV_to_Y

Label: Connection between the two unidentified spaces
SCOTCH description: transition between Space V to Space Y

3D representations: TrV_to_Y_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696673692>

SCOTCH URI: **TrX_to_Q**

Label: Secondary entrance to the room above the triclinium

SCOTCH description: transition between Space X to Space Q

3D representations: TrX_to_Q_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696674112>

SCOTCH URI: **TrX_to_O**

Label: Stairs leading to the entrance of the room above the triclinium

SCOTCH description: transition between Space X and Space O

3D representations: TrX_to_O_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31696673472>

SCOTCH URI: **TrX_to_O_F01**

Label: Banister along the stairs leading to the secondary entrance of the room above the triclinium

SCOTCH description: First feature of the transition between Space X and Space O

3D representations: TrX_to_O_F01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31595179920/in/album-72157678130760216/>

SCOTCH URI: **TrG_to_P01**

Label: First flight of stairs connecting the kitchen with the second storey room above it

SCOTCH description: First transition between Space P to Space G

3D representations: TrG_to_P01_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31929457976>

SCOTCH URI: **TrG_to_P02**

Label: Second flight of stairs connecting the kitchen with the second storey room above it

SCOTCH description: Second transition between Space P to Space G

3D representations: TrG_to_P02_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31157021823>

SCOTCH URI: **TrG_to_P03**

Label: Connection between the kitchen and second storey room above it

SCOTCH description: Third transition between Space P to Space G

3D representations: TrG_to_P03_79.3DS available at: <https://www.flickr.com/photos/134064462@N06/31929457886>

Appendix B. The SCOTCH cookbook. Introduction to the SCOTCH documentation framework for 3D visualisation of cultural heritage

The SCOTCH framework for documenting 3D visualisation of cultural heritage is made up of an ontology (called scotch) and a set of guidelines. The ontology is meant to be essential, and, along with some specific terms (prefix: scotch), also includes classes and properties from the Dublin Core ontology (prefix: dc) and the Provenance Ontology (prefix: provo). For demonstration purposes, this cookbook will refer to a sample case study, which is the Iseum in Pompeii and two variant 3D visualisations of it, and will follow a naming convention called SCaT. The latter is not a requirement for the use of the documentation framework. A standard naming convention for both the representations and their objects would facilitate searches across 3D models, but different naming conventions can easily be aligned in Linked Open Data, for example via relationships such as owl:sameAs, or skos:closeMatch

Getting started

The documentation should ideally start at the same moment as the modelling process does. However, it can be retrospectively applied to pre-existing 3D visualisations. At its present stage of development, the SCOTCH framework focuses mostly on architecture and built environments. A wider range of applications will be developed by other users, according to their needs, but within a compatible, general framework.

Step 1: Looking at the object of representation

The first step is to look at the object of representation (the referent), and break it down into smaller units (here called “spatial elements”). This is a mandatory step in every modelling process, as well as in its documentation. What are the main areas? How are they separated from each other? How do they relate to each other?

Step 2: Dividing space into elements (with or without the suggested naming convention SCaT)

The identification of the different spatial elements is not a straightforward operation, and does require a certain amount of speculation, especially when looking at built environments that are ruined or have almost disappeared. The (optional) method followed in this example identifies four main typologies of spatial elements:

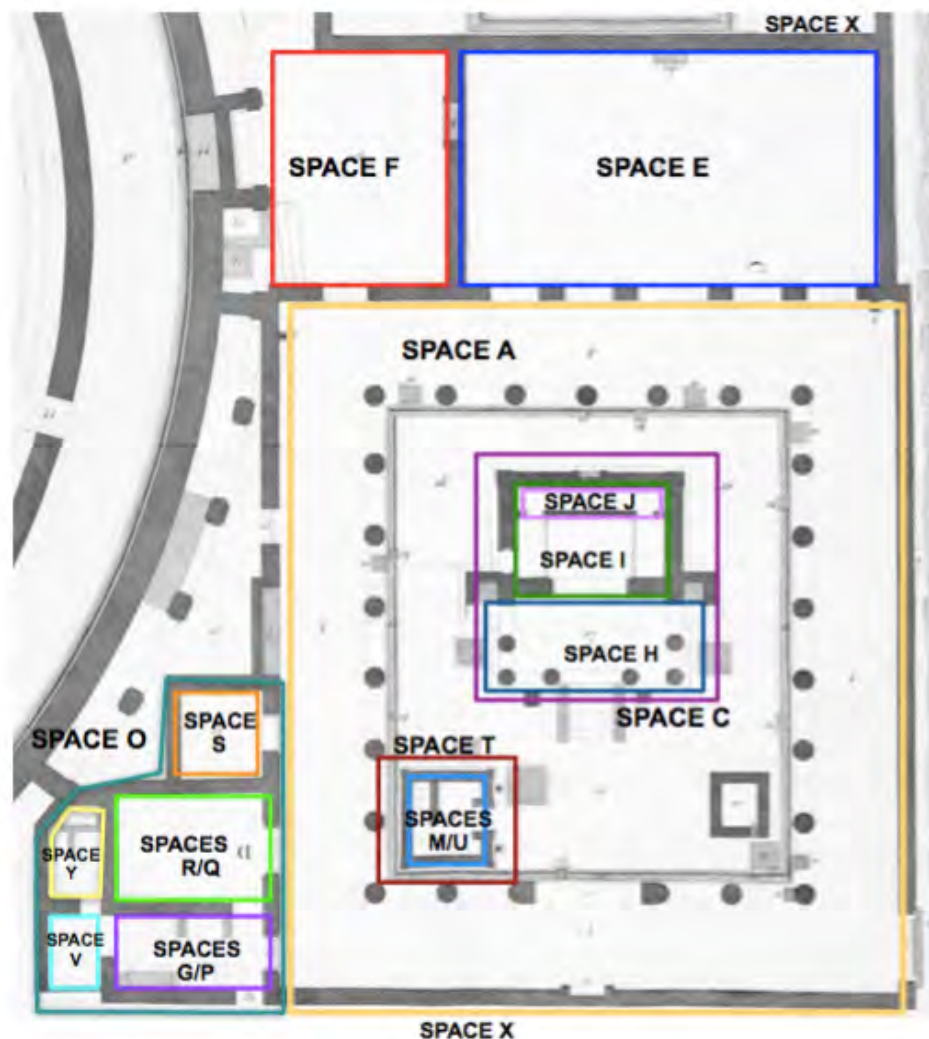
- Spaces: where human activities could take place;
- Constraints: that delimit spaces;
- Transitions: that allow movement from one space to another;
- Features: that indicate a distinctive attribute or aspect of something.

More information on each of these categories and the underlying rationale can be found in the section 3.2.2 of the thesis.

Looking at our examples, the Pompeian Iseum, the following plan shows how the building has been divided into spaces (see image below).

Please note that:

- a) Spaces can have an unlimited number of subspaces. Look, for example, at Space C (the main temple) and its subspaces Space H, Space I and Space J.
- b) A space has its own name, independent of its subspaces. Again, looking at our example, we can see that Space C identifies the whole Temple of Isis, although the temple itself is made up of Space H, Space I, and Space J, all subspaces of Space C.



SPACE A: Portico	SPACE R: Triclinium
SPACE C: Temple of Isis	SPACE Q: Second storey room above the triclinium
SPACE H: Pronaos of the Temple of Isis	SPACE S: Cubiculum
SPACE I: Cella of the Temple of Isis	SPACE V: Unidentified space
SPACE J: Cellar of the Temple of Isis	SPACE Y: Unidentified space
SPACE E: Ekklesiasterion	SPACE T: Purgatorium
SPACE F: Sacrarium	SPACE M: Ground floor of the purgatorium
SPACE O: Private Rooms	SPACE U: Underground room of the purgatorium
SPACE G: Kitchen	SpaceX: Area outside the Iseum
SPACE P: Second storey room above the kitchen	

Step 3: Assigning unique names

For the nature of Linked Open Data (LOD), it is not necessary that the entities have a human-readable name (although at least attaching a human-readable label is recommended). Assigning names that are randomly generated strings is a perfectly viable option, as long as each name is unique. In our example, we chose a naming convention that is partly human-readable, to help researchers understand the nature of a spatial element at first glance, once they are familiar with the naming rationale. If you wish to follow the SCaT naming convention suggested by the SCOTCH framework, here is how to do it:

Start by identifying the spaces that are usually the easiest spatial element to spot. Spaces will be named with the word "Space" followed by a randomly assigned letter of the alphabet. For example: SpaceA, SpaceB, SpaceC and so on. This denomination is in no way hierarchical. It means that SpaceA is neither more important, nor older, nor bigger than SpaceB.

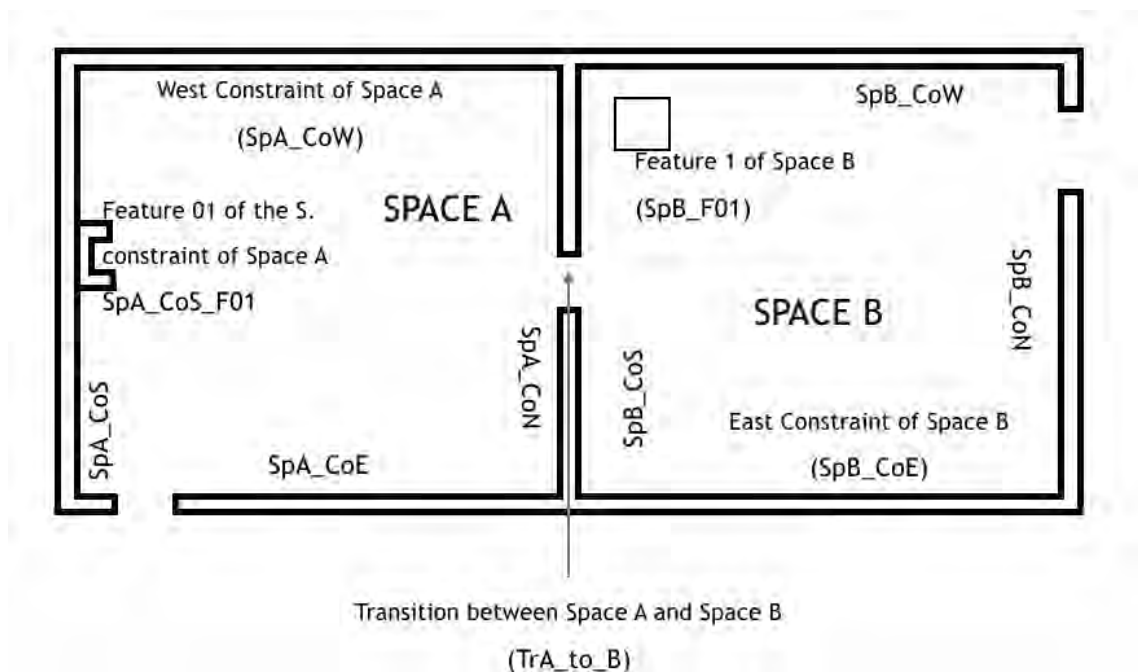
Also remember to name:

- a) Spaces that are on underground levels or second storeys, if any. It is easy to overlook them when working with plans of buildings (Cf., for example, SpaceU in the plan above, the underground level of the Purgatorium);
- b) Spaces that will appear in the model but are not visible in the remains or in its recordings (i.e. hypothetical spaces, such as, for example, SpaceP and SpaceQ, that are the hypothetical second storeys above SpaceG and SpaceR. More information about hypothetical spaces can be found in section 4.1 of the thesis.)

The elements that delimit spaces, either material or conceptual, are what we have called "constraints" (for more information about constraints, please see section 4.1 of the thesis). Constraints are always named according to the space they define. The name of a constraint, therefore, starts with a prefix that identifies the space we are referring to: the letters "Sp" followed by the letter in the name of the space. For example, "SpE" will be the prefix for SpaceE. Then we add the abbreviation "Co" for Constraint, followed by a letter that indicates if we are talking about the north, south, west, east, up or down constraint. The six constraints of Space E will then be named:

SpE_CoN, SpE_CoE, SpE_CoS, SpE_CoW, SpE_CoU, SpE_CoD. It will read as: north constraint of space E, east constraint of space E, south constraint of space E, west constraint of space E, up constraint of space E, down constraint of space E.

Note: walls, which are the most common constraint, often delimit more than one space, one for each side of the wall. In SCOTCH, the constraint refers to the surface more than the solid wall. Each surface is constraint to a different space, as shown in the following diagram:



Transitions generally link two spaces. Their function is mirrored in the name. Transitions' names start with the prefix "Tr", followed by the letter of one of the two spaces connected, underscore, the letters "to", another underscore, and the letter of the other space connected. For example, the transition between SpaceA and SpaceC will be named TrA_to_C. The order in which the two spaces appear in the name is irrelevant, as long as it stays the same once the element has been named. If there is more than one transition between two spaces, a number is added after the name. For example, TrA_to_C01, TrA_to_C02 and so on.

Finally, we should consider features. They are the most flexible spatial element, so their denomination shows more variety (more information about features can be found in section 3.2.2. of the thesis). There are four main kinds of features in the convention we are using for our example:

- a) Features of spaces: their name starts with the prefix of the space, followed by the letter F and a number. For example, a feature in space B will be called: SpB_F01 (Cf. the diagram above).
- b) Features of constraints: their name is composed by the name of the constraint, followed by the letter F and a number. For example, the feature of the south constraint of space A will be named: SpA_CoS_F01 (Cf. the diagram above).
- c) Features of transitions: their name is composed by the name of the transition, followed by an F and a number. For example, a feature of the transition between space A and space C will be named: TrA_to_CF01.
- d) Features of features (in the case, for example, of the decoration of a niche): their name is composed by the name of the container feature, followed by the letter F and a number. For example, the feature of a feature of the north constraint of space E will be named: SpE_CoN_F01_F01.

All these names are not descriptive of the qualities or functions of the spatial elements. Descriptions will be attached via LOD. We want to stress one more time that following this convention for the naming of the files is by no means a requirement, but simply a suggestion that may help the modeller to understand the nature of the spatial elements, and some of their relationships, by looking at their names.

Step 4: Assigning status to spatial elements

When working with ancient buildings it is difficult sometimes to draw a line between actual and hypothetical spaces. Material remains are easy to consider actual, especially if they are still standing. The status of those that have been destroyed (or never existed), however, is more controversial. SCOTCH distinguishes between two statuses for a spatial element: "material" and "hypothetical":

- a) An element is labelled as "material" when it still exists or its existence has been attested at least once, i.e. if we can point to a document that mentions or reproduces it. The spatial element belonging to the category "material" is linked to the document that attests its existence via the property `scotch:isAttestedIn`. For example:

```
SpA_CoN scotch:isAttestedIn <https://www.wikiart.org/en/giovanni-battista-piranesi/general-plan-embracing-the-temple-of-isis-two-theaters-the-district-soldiers-a-large-porch-and>
```

(The latter is the URL of the plan of the temple drawn by Piranesi, and available online on wikiart).

Having a `scotch:isAttestedIn` statement is a condition necessary and sufficient to give the element the status of “material”. Documents can be linked in various forms, from bibliographic citations, to URIs, to web URLs.

- b) An element is “hypothetical” when it is believed by the researcher to have existed, but has never been materially attested. This includes those elements that, although missing, can be considered very likely, such as, for example, a (never attested) architrave on top of an (attested) colonnade. No matter how sure the modeller is of the probable existence of a spatial element, if it has not been attested, its status will always be “hypothetical”. Each hypothetical element must be accompanied by a `scotch:hypothesisedIn` property that connects these elements to the author of such hypothesis and attaches a timestamp to it. These educated guesses are stored in the triplestore as “hypothesis#” followed by a number (for example `hypothesis#1`, `hypothesis#2`, `hypothesis#3`, and so on). Each of these hypotheses must have a `dc:author` and `dc:date` property. For example:

```
SpG_CoU scotch:hypothesisedIn hypothesis#1
```

Where `hypothesis#1` is a guess made by the 3D modeller.

In some cases, an hypothetical element can also be hypothesised in a previous restoration, and can therefore be cited as an image or a bibliographical reference. For example:

```
SpE_CoU scotch:hypothesisedIn piranesiRestoration.jpg
```

Step 5: Modelling explicit spatial relationships

Basic information about the relationships between spatial elements is already present in their names when following the SCaT convention just discussed. In addition — or as an alternative — SCOTCH provides simple properties to express relationships between spatial elements more explicitly in LOD. Users who prefer not to use SCaT may wish to skip this step as well.

A space, for example `SpaceA`, has a number of constraints. The relationship between a constraint and the space it delimits can be traced in the name of the constraint itself, which always starts with a prefix declaring the related space. As we have seen, the north constraint of space A will be called `SpA_CoN`. But the relationship is also made explicit by the ontology. `SpaceA` and `SpA_CoN` are linked by the property `scotch:isConstrainedBy`:

```
SpaceA scotch:isConstrainedBy SpA_CoN  
SpaceA scotch:isConstrainedBy SpA_CoE
```

And so on for all the constraints.

The other spatial relationships modelled by SCOTCH are: `isFeatureOf`, `isTransitionBetween`, `isSubspaceOf`. All of them have inverse relationships (`isConstraintOf`, `hasFeature`, `hasTransition`, `isSuperspaceOf`). More information about all the different properties that link the spatial elements together can be found in section 4.1 of the thesis, as well as in the description of all SCOTCH properties.

Step 6: Describing the 3D representations

So far, the cookbook has dealt with the division and naming of the object. The main goal of SCOTCH, however, is to document the three-dimensional representations of that object. The 3D representations are connected to the spatial elements via the property `dc:depicts`. There is no strict rule on the naming, as long as each 3D representation is connected to its referent via `dc:depicts`. As discussed before for the SCaT convention, the naming process here described for the 3D elements is simply a suggestion.

The next step is to relate, via LOD, each of the parts of the 3D model to the spatial element that they represent. In our proof of concept, we start by giving to the entire 3D model a short name. For example, the two 3D models of the Iseum that we will use as examples are called Iseum79 and IseumGT (as they represent respectively the hypothetical look of the Iseum in 79 CE and during the years of the Grand Tour). In this case study, the 3D representations are named after the spatial element they visualise, followed by the suffix “3DS”, followed by a short code that identifies the 3D model in its entirety. The 3D representations that are part of the model called Iseum79, for example, have the code “79” in their names. The use of a code that recalls the 3D model of origin (Iseum79 in this case) proved useful in comparing 3D representations of the same spatial element from two different 3D models (Iseum79 and IseumGT). A 3D representation of SpaceA of the Iseum belonging to the model Iseum79 will be named SpaceA.3DS_79. The relationship with the object of representation will be expressed as follows:

```
SpaceA.3DS_79 dc:depicts SpaceA.
```

Step 7: Components:

A spatial element could be measured and deconstructed in countless ways. In order to reach a higher level of granularity (which may prove useful for documentation of smaller scale objects, as we will see in the following section), SCOTCH suggests dividing a 3D representation into its main informative components. In this example, we have limited the components to dimensions (e.g. height, length, depth and circumference), parts and textures. However, other components such as angle or curvature could be introduced.

Dimensions: are named adding the suffix “Cm” (for “component”), followed by # and a number, to the name of the related 3D representation. For example, a dimension of the north constraint of space A in the model Iseum79 will be named: SpA_CoN.3DS_79_Cm#1

Therefore:

```
SpA_CoN.3DS_79 scotch:hasComponent SpA_CoN.3DS_79_Cm#1
```

Each dimension always has a numeric value. For example:

```
SpA_CoN.3DS_79_Cm#1 owl:value 625cm
```

In our example, the numeric value represents the height of the north constraint of space A. Information about dimensions can be expressed regardless of the naming

convention used for the 3D representations. It is also important to stress that the components refer to the 3D representation and not to the object of representation.

Parts: Some 3D elements are particularly complex in shape and could be better described and documented when broken down into smaller sub-elements. There is no rigid rule about how to divide an element, although sometimes it is the modelling logic that can guide this choice. Each part is called by the name of the original 3D element, followed by the suffix “P” and a number. For example: SpA_CoU.3DS_79_P01 (reads as: part one of the Up constraint of Space A in the Iseum79 3D representation). Parts are not mandatory; they are created only when it facilitates the documentation or the modelling work. In many CAD softwares, parts can be grouped together, and treated as a single element at the end of the modelling. In LOD, 3D elements and their parts are connected through dc:hasPart or dc:isPartOf. So:

```
SpA_CoU.3DS_79_P01 dc:isPartOf SpA_CoU.3DS_79
```

Textures: If the 3D element is textured, the texture should be documented and linked to the 3D element via the property scotch:hasTexture. For example:

```
SpA_CoN.3DS_79 hasTexture textureimage.jpg
```

This property refers to the image that has actually been used as a texture. If the texture comes from a source image that has been edited, the texture is connected to the original image via scotch:hasReference. For example:

```
textureimage.jpg scotch:hasReference sourceimage.jpg
```

As usual, the source image can be referenced in various ways, including by citation, URI, web URL. Of course, the authors of the texture and the author of the source image may be different. For example, the author of the source image might be Piranesi, while the author of the texture might be a researcher who edited the source image for the purpose of texturing. The author of the texture can be identified via name, orchID, web URL and so on:

```
textureimage.jpg scotch:3Dcreator Valeria Vitale  
sourceimage.jpg dc:author GB Piranesi
```

Step 8: Assigning categories to sources:

In the SCOTCH framework, all the sources of information that have contributed to the final shape of the 3D model are stored as entities and receive a type. Currently, SCOTCH allows 7 different categories, but more can be created. More information about the source types in SCOTCH can be found in section 4.4 of the thesis. SCOTCH includes uncitable sources such as guesses and speculations. The 3D elements are connected to the different types of sources via specific relationships that underline their nature. The most important step in the SCOTCH documentation framework is to identify the sources used during the modelling process, give them a URI if they don't have one already, and then connect each 3D element, or its single

component, to the source that has informed or inspired it. The link between a 3D element – or one of its components – and the related source will be expressed differently, according to the different type of source.

A 3D element, or one of its components, that has been informed by a primary source will look like this:

```
SpA_CoN.3DS_79_Cm#2 scotch:hasEvidenceIn SourceFile
```

Where the SourceFile (in any format, including image, citation, URI) has type “primary”. It means that one of the components of the north constraint of space A in the model Iseum79 (the length of the constraint) is based on a primary source, such as archaeological hard measurements. A 3D element, or one of its components, that has been informed by a secondary source will look like this:

```
SpA_CoN.3DS_79_Cm#1 scotch:hasReferenceIn ReferenceFile
```

Where ReferenceFile (in any format, including image, citation, URI) has type “secondary”. A 3D element, or one of its components, that has been derived from another element will look like this:

```
SpA_CoS.3DS_79_Cm#1 scotch:isDerivedFrom SpA_CoN.3DS_79_Cm#1
```

Where SpA_CoS.3DS_79_Cm#1 is already documented

The sources belonging to the type “guessed” should also receive a subtype category. The ones currently included in SCOTCH are: “precedent”, “canon”, “scholarship”. More information in the subtypes of sources can be read in paragraph 4.4. According to the nature of the source document, it will be linked to the 3D element (or one of its components) either using scotch:hasEvidenceIn or scotch:hasReferenceIn. For all the sources belonging to the uncitable categories (i.e. the types “speculative”, “contextual” and “imaginative”), the link with the 3D element (or one of its components) will be modelled via scotch:hypothesisedIn. Each of the pieces of information (including those which are not in a traditionally citable format) that has inspired the modelling of a 3D element has to receive an URI, an author, and a date. These entities will be named adding the suffix “So” followed by # and a number, to the name of the 3D element they refer to. For example, the informed guess behind the values expressed in SpC_CoN_GT_Cm#2 will be called SpC_CoN_GT_Cm#2_So#1. The two entities will be linked via the scotch property scotch:isSourceFor.

```
SpC_CoN_GT_Cm#2_So#1 scotch:isSourceFor SpC_CoN_GT_Cm#2
```

Each of the sources that is not traditionally citable has to refer to an hypothesis in the triplestore.

For example, if the information about the height of the east constraint of Space I is based on a speculation by the 3D author, the latter will create an entity called hypothesis#11, complete with author and date. In RDF:

```
SpI_CoE_GT_Cm#2_So#1 scotch:hypothesisedIn hypothesis#11.  
hypothesis#11 dc:author Valeria Vitale;  
dc:dateCreated September 2016;  
dc:description "The height of the walls in the main temple have been  
generically (but arbitrarily) lowered, to show damage."
```

Connecting 3D elements (or their components) to their sources, and categorising the latter, is basically the core function of SCOTCH. The operation can be as rough or granular as the sources allow and/or the 3D authors deem fit to their research purpose. Associating a 3D element to its sources is what makes it documented. Dividing the sources into categories is what drives their different modelling and what enables, for example, searches that isolate only 3D elements based on certain kinds of provenance.

Step 9: Modelling disagreement and inconsistencies

Often, 3D visualisations are based on interpretations of the only available sources. In other cases, the 3D author makes a choice among the various possibilities. Such choices might be confirmed by other sources, of the same or a different nature. In SCOTCH, the supporting sources are linked to the main one via the property `scotch:isSupportedBy`. In contrast, when the 3D author had to make a choice, but wants to acknowledge the existence of discordant interpretations or even of inconsistent data, the property `scotch:isNotSupportedBy` can be used. For example, the shape of the ekklesiasterion's roof in the virtual restoration of the Iseum (SpE_CoU_F01_79_Cm#2_So#1) is based on a picture (Image#40 in the triplestore) of the scale model of the Iseum that is displayed in the Museo Archeologico Nazionale di Napoli (MANN). However, Piranesi had fairly different ideas about it, and that restorative hypothesis is definitely contradicted (`scotch:notSupportedBy`) in his restorative view of the ekklesiasterion (Image#01 in our triplestore).

```
SpE_CoU_F01_79_Cm#2_So#1 scotch:hasReference Image#40;  
scotch:isNotSupportedBy Image#01
```

Linking more than one source makes the documentation more robust and might highlight relationships among the sources that were not immediately apparent.

Step 10: Connecting external entities

So far, we have explored the use of SCOTCH to document the different 3D elements in a 3D visualisation, connecting them to both their object of representation (referent) and the sources that have informed the 3D elements themselves. The SCOTCH framework can also be used to establish relationships that look beyond the single 3D model. More specifically:

- a) Links with other entities: for example, portable artefacts with their own URIs (from an archive, museum catalogue, wikidata page) can be connected to the spatial elements of the referent via the `scotch:wasFeatureOf` relationship. For example, the fresco fragments displayed at the MANN, which depict a gorgoneion between lionesses (MANN1_17 in our triplestore, according to the MANN cataloguing system), used to be located on the south wall of the porticus (SpA_CoS). Therefore:

```
MANN1_17 scotch:wasFeatureOf SpA_CoS
```

This allows a basic but useful digital unification.

- b) Links with other representations: the spatial elements of the referent can be connected to various representations, in 2D as well as 3D, via the `dc:depicts` property. This ensures multiple views and enables the user to compare different ideas and interpretations. For example, the Purgatorium (Space T) is depicted in both 3D visualisations (SpaceT.3DS_GT and SpaceT.3DS_79), as well as in a number of secondary sources in the triplestore, such as drawings by R. H. Sharp (Image#39) and Desprez (Image#34).

```
SpaceT.3DS_GT dc:depicts SpaceT.  
SpaceT.3DS_79 dc:depicts SpaceT.  
Image#39 dc:depicts SpaceT.  
Image#34 dc:depicts SpaceT.
```

Step 11: Assigning types to visual and written sources and comparanda

Users of the SCOTCH framework may find it useful for their research purposes to assign a type to the secondary sources (both depictions and descriptions) used as comparanda during the modelling process. For the visual documents, the types currently featured in SCOTCH are: “photographs”, “records”, “restorations”, and “impressions”. More information about these subcategories can be found in section 5.2.1 of the thesis. For the written documents, the subcategories are: “guidebooks”, “literature” and “reports” (for more information about these subcategories, see section 5.2.2). These divisions are entirely optional, but it may be helpful to divide the sources, as their different purposes may imply different degrees of accuracy or reliability.

Appendix C. The SCOTCH ontology: properties and classes

Description of the physical referent:

All spatial elements described must belong to either of the two classes: “material” or “hypothetical”. They are mutually exclusive.

scotch:material: the spatial element still exists in the physical world, or existed at some point in time and was documented. This property cannot be applied to elements that are very likely to have existed but have never been documented. It is mandatorily complemented by scotch:isAttestedIn

scotch:isAttestedIn: provides a reference for the existence of a spatial element at a certain moment in time. It can point to bibliographical references, pictures of actual remains, blueprints, or any other attestation of the spatial element.

scotch:Hypothetical: the spatial element may or may not have existed in the material world, but there is no attestation of it. It is mandatorily complemented by scotch:hypothesisedIn.

scotch:hypothesisedIn: associates a hypothetical spatial element with the educated guess that states its speculative existence. It points to an hypothesis that is held in the triplestore and has received a URI. This property must be complemented by information about author (dc:author) and date (dc:date). It can also be used to state a connection between a 3D element and the non-documentable source that has inspired it. More specifically, it links a 3D element with sources belonging to the categories “speculative”, “contextual” and “fictional” (see further, under *Types of sources*). It is the inverse of scotch:isHypothesisFor

scotch:Space: describes the nature of a spatial element and qualifies it as “space”, i.e. an element where human activity can take place.

scotch:isSubspaceOf: states a relationship between two spaces, where one (subspace) is contained by the other (superspace). There is no limit to the number of subspaces a space can have. It's the inverse property of scotch:isSuperspaceOf

scotch:isSuperspaceOf: states a relationship between two spaces, where one (superspace) contains the other (subspace). It is the inverse property of scotch:isSubspaceOf.

scotch:Constraint: describes the nature of a spatial element and qualifies it as a “constraint”, i.e. an element that delimits a space.

scotch:isConstraintOf: states a relationship between a constraint and the space it delimits. Although the most common spaces tend to have six constraints (north, east, south, west, up and down), there is no specific limit to the number of constraints a space can feature, as more complex elements might require further fragmentation. It is the inverse property of scotch:isConstrainedBy.

scotch:isConstrainedBy: states a relationship between a space and the constraints that delimit it. A space is constrained by more than one constraint. It is the inverse of scotch:isConstraintOf.

scotch:Feature: describes the nature of a spatial element and qualifies it as a “feature”, i.e. a distinctive attribute or aspect of something.

scotch:isFeatureOf: states a relationship between a feature and the spatial elements to which it belongs. Any spatial element can have a feature, including features themselves. This property can be used when the relationship between the feature and the related spatial element is still valid, i.e. the spatial element and its feature are still materially linked. If such physical connection has been broken (if, for example, the feature has been moved or destroyed) then the relationship scotch:wasFeatureOf must be preferred.

scotch:hasFeature: states a relationship between any spatial element and its feature. It's the inverse relationship of scotch:isFeatureOf. Like the latter, it can only be used if the relationship can be still observed in the material world. If such physical connection has been broken (if, for example, the feature has been moved or destroyed) then the relationship scotch:hadFeature must be preferred.

scotch:wasFeatureOf: states a relationship between a feature and the spatial elements to which it belonged. It has to be used when the material link between the feature and the spatial element has been broken (if, for example, the feature has been moved or destroyed). This relationship must always be documented by referring to sources, for example, in the form of images or bibliographical references (via scotch:isAttestedIn).

scotch:hadFeature: states a relationship between any spatial element and its feature. It has to be used when the material link between the feature and the spatial element has been broken (if, for example, the feature has been moved or destroyed). This relationship must always be documented, referring to sources in any format (via scotch:isAttestedIn).

scotch:isTransitionBetween: states the relationship between a transition and the spaces it connects. It is the inverse of scotch:hasTransition.

scotch:hasTransition: states the relationship between a space and the transition that connects it to another space. It is the inverse of scotch:isTransitionBetween.

Description of the 3D representations of the referent:

scotch:3Dcreator: this property differs from dc:author and states the specific authorship of a 3D file or one of its components. A 3D creator is assumed also to be the author of the documentation of the 3D element they produced (and all related RDF statements such as the kind of sources that have informed or inspired it).

scotch:components: artificial division of the 3D representation for modelling or documentation purposes. It currently includes three subcategories, but more can be added, according to each project's needs:

- scotch:dimensions: expresses the value of the dimensions of a 3D element.
- scotch:parts: geometrical division of a single 3D element. A part cannot be considered a meaningful unit, but only a useful fragmentation.
- scotch:textures: images that have been used to texture a 3D file.

scotch:isComponentOf: states a relationship between a component and its related 3D element. Each component can only be linked to a single 3D element.

scotch:hasComponent: states a relationship between a 3D element and one of its related components. Each 3D element can have multiple components.

scotch:hasTexture: states the relationship between a 3D file and the image that has been used to texture it. It points to a digital image, either as an online upload or a reference. It refers strictly to the image that has been actually used as texture. The pre-edited source image can be linked via scotch:hasReference. Its inverse property is scotch:isTextureOf.

scotch:isTextureOf: states the relationship between an image and the 3D files that use it as a texture. The same texture can be used by multiple 3D files. Its inverse property is scotch:hasTexture. Each texture should be linked to its source image (via scotch:hasReference).

Connecting the 3D files to the sources

scotch:hasSourceType: assigns a category to the sources that have informed a 3D representation. In the described case study, there are 7 different values, but more can be created and defined.

scotch:isEvidenceFor: expresses the connection between a source of the type “primary” and the 3D element it has informed. The same document can be evidence for more than one 3D element. Its inverse property is scotch:hasEvidenceIn.

scotch:hasEvidenceIn: states a connection between a 3D element and the source(s) of the type “primary” that have informed it.

scotch:isReferenceFor: states a connection between a source of the type “secondary” and the 3D element it has informed. The same source can be a reference for more than one 3D element. Its inverse property is scotch:hasReference.

scotch:hasReference: states a connection between a 3D element and the source(s) of the type “secondary” that have informed it. In the case of bibliographical citations, each specific passage in a book may receive a single URI, to differentiate it from other citations in the same book. In other cases, the reference may be to the entire publication.

scotch:isDerivedFrom: states a link between a 3D element and another 3D element that is already documented and is used as a source of information. Its inverse property is scotch:derives.

scotch:derives: states a link between an already-documented 3D element and another 3D element that is derived from it. Its inverse property is scotch:isDerivedFrom.

scotch:isSupportedBy: states a relationship of concordance among the sources that have informed a 3D element and another, supporting one. Its inverse property is scotch:supports.

scotch:supports: states a relationship of concordance among an additional source and the main one that have informed a 3D element. Its inverse property is scotch:isSupportedBy.

scotch:isNotSupportedBy: states a relationship of discordance among the sources that have informed a 3D element and another, non-supporting one. Its inverse is scotch:doesNotSupport.

scotch:doesNotSupport: states a relationship of discordance between an additional source and the main one that has informed a 3D element. Its inverse property is scotch:isNotSupportedBy.

scotch:hasCanonicalModelIn: states a relationship between a 3D element and the source of type “guessed” and subtype “canon” that has informed it. Its inverse property is scotch:isCanonicalModelFor.

scotch:isCanonicalModelFor: states a relationship between a source of type “guessed” and subtype “canon” and the 3D element that has informed it. Its inverse property is scotch:hasCanonicalModelIn.

scotch:hasPrecedent: states a relationship between a 3D element and the source of type “guessed” and subtype “precedent” that has informed it. Its inverse property is scotch:isPrecedentFor.

scotch:isPrecedentFor: states a relationship between a source of type “guessed” and subtype “precedent” and the 3D element it has informed it. It’s the inverse property of scotch:hasPrecedent.

scotch:isMentionedIn: states a relationship between a spatial element and a written source that mentions it. Each 3D element can be mentioned in several written sources. It is the inverse property of scotch:mentions.

scotch:mentions: states a relationship between a written source and the spatial element that is mentioned in it. Each written source can mention several 3D elements. Its inverse property is scotch:isMentionedIn.

scotch:isSourceFor: states a relationship between a piece of information (in a non-traditionally-citable format) and the 3D element that it has informed or inspired. Its inverse property is scotch:hasSourceIn.

scotch:hasSourceIn: states a relationship between a 3D element and the piece of information (in a non-traditionally-citable format) that has informed or inspired it. Its inverse property is scotch:isSourceFor.

scotch:isHypothesisedIn: states a relationship between an informed hypothesis and the pieces of information it has generated.

Types and sub-types of sources (according to provenance)

Primary: describes the relationship between a 3D representation and its source when the material referent of the digital representation(s) still exists, and its dimensions and/or position have been measured and published.

Secondary: describes the relationship between a 3D representation and its source when the material referent does not exist any more or has been subsequently modified, but has been documented in the past and the documentation is still available; or when the material referent still exists but information has nonetheless been derived indirectly from secondary sources.

Derived: describes the relationship between a 3D representation and its source when the material referent does not exist any more but information can be reasonably derived from material clues; or when a 3D representation has been informed by another, documented, 3D element (for example by mirroring or cloning).

Guessed: describes the relationship between a 3D representation and its source when the material referent does not exist any more and has not been documented, but can be visualised according to a citable source, such as well accepted standards (subtype: canon), documented precedents (subtype: precedent), or previous scholarship (subtype: scholarship).

Speculative: describes the relationship between a 3D representation and its source when the material element does not exist any more, but can be visualised according to the researcher's experience, knowledge, or intuition. However, no citable source can be identified.

Contextual: describes the relationship between a 3D representation and its source when the digital element has been added for aesthetic and communication purposes, but still within the boundaries of the general historical knowledge of the context.

Fictional: describes the relationship between a 3D representation and its source when the element has not been created for a scholarly purpose and does not aim at historical accuracy. However, some characteristics of a historical referent can still be recognised.

Types and sub-types of sources (according to media)

- Bibliographical References: to this category belong all the sources that have directly informed the 3D representation and are expressed in the form of canonical bibliographical citations.
- Documents: to this category belong all documents that have been created first-hand by the 3D author for the purpose of documentation (such as, for example, hard measurements).
- Hypotheses: to this category belong all the educated guesses formulated by the 3D author that, for their nature, cannot be cited in any traditional format. They are expressed as hypothesis#1, hypothesis#2 and so on. Each of them must display a brief description, an author, and a time stamp.
- Written Sources: to this category belong all the written sources that have contributed to contextualising the knowledge of the represented piece of cultural heritage. They have been further subdivided into the following sub-categories:
 - Reports: to this sub-category belong those texts that aim at describing the represented object in an official, scientific way;
 - Literature: to this sub-category belong those texts that use the represented object in a literary and fictional context;
 - Guidebooks: to this quite specific subcategory belong tourist guidebooks and popular accounts of cultural heritage, which have been considered somehow halfway between the two previous categories.
- Images: to this category belong all the visual sources that have directly and indirectly informed the representation of the piece of cultural heritage and the knowledge of its context. They have been further subdivided into the following sub-categories:
 - Photographs_Videos: to this sub-category belong the visual documents in the form of photographs or videos;
 - Impressions: to this sub-category belong the visual documents that reproduce the represented object for artistic and aesthetic purposes;
 - Records: to this sub-category belong the visual documents that aim at recording the actual state of the represented object. They must include a scale.
 - Restorations: to this sub-category belong the visual documents that attempt a virtual reconstruction of the represented object.

Appendix D. Three hypothetical user cases

The SCOTCH framework aims at creating data that are searchable in different ways, and are relevant to an academic community that is wider than just the 3D authors. To illustrate SCOTCH's potential in a research context, we designed three hypothetical user cases and their related scenarios. It should be remembered that the proof of concept produced for this thesis only stores data that were necessary to the documentation of a particular 3D project. However, the user cases here described look, hypothetically, at a database that is larger and more complex than the one actually available in the current triplestore.

Hypothetical user case #1: Digital unification

In the proof of concept discussed in this thesis – the visualisations of the Pompeian Iseum – the focus has always remained the architecture. However, as mentioned in section 5.1 of the thesis, the SCOTCH framework also allows the linkage of the 3D representations with external information, such as, for example, data about the portable items that used to belong to a built environment.

In the first hypothetical user case, an art historian wants to find information about the portable artefacts that belonged to the Pompeian Iseum. The user could use SCOTCH to query the documentation of one or more 3D representations of the Iseum, looking for all the entities in the class `scotch:feature` that have the property `scotch:wasFeatureOf` (or, because the results may not be identical depending on the integrity of the data, all the entities in the class `scotch:Spatial_Element` that have the property `scotch:hadFeature`).

"Find me all the features in this dataset that used to be part of a spatial element."

<pre>PREFIX scotch: <http://www.semanticweb.org/david/ontologies/2016/7/SCOTCH#> SELECT ?feat ?a ?b WHERE { ?feat a scotch:feature ; scotch:wasFeatureOf ?x }</pre>

Information in an RDF graph does not need to be complete to be valid. The results returned from the query will only include the data that have been input by the 3D authors of the models, because of their own research needs. However, this could be a useful starting point, especially when considering that `scotch:hadFeature` needs to be complemented with an attestation, as the relationship between the artefact and the spatial element cannot be observed anymore. This means that the query will also, indirectly, return essential bibliography, always of crucial importance in any research.

Searching the data produced by SCOTCH will return more than just a list of artefacts, which may be available from other sources such as museum catalogues or other scholarly publications. It will offer, for each of the artefacts that has been recorded within the documentation, a link to the spatial element to which it used to belong, and offer the opportunity to contextualise, partly, the object in its spatial environment, when looking at the representations of the related architectural context.

The aim of SCOTCH is not only to document the 3D visualisations of cultural heritage, but also to record, and share, the research process that usually precedes the modelling per se. That is why SCOTCH is designed to encourage the 3D authors to include in the framework not only the documents that have been used as main references during the modelling, but also the other representations, in images and words, that have contributed to developing the 3D author's

entire knowledge of the cultural heritage. If a certain number of external representations have been connected to the 3D elements, the art historian in our example could look at representations of the portable artefacts of interest beyond the 3D models, searching, for example, the older representations that were possibly executed when the portable artefact of interest was still in place. To do so, the user should look for those images in scotch:images that depicts (dc:depicts) any feature (scotch:feature) that has the property scotch:wasFeatureOf. If this search doesn't return enough results, it could be widened to look for images (scotch:images) that depict (dc:depicts) spatial elements (scotch:Spatial_Element) that have the property scotch:hadFeature. All the results should, of course, be individually checked to identify the relevant ones (the fact that a spatial element had a feature does not necessarily mean that the latter was included in the representation).

"Find me all images in this dataset that represent features that used to be part of a spatial element, or that represent spatial elements that used to have features."

```
PREFIX scotch: <http://www.semanticweb.org/david/ontologies/2016/7/SCOTCH#>
PREFIX dc: <http://purl.org/dc/elements/1.1/>
SELECT ?img ?feat ?elm WHERE {
  ?img a scotch:images ;
       dc:depicts ?feat .
  ?feat a scotch:feature ;
        scotch:wasFeatureOf ?x }
UNION {
  ?img a scotch:images ;
       dc:depicts ?elm .
  ?elm a scotch:Spatial_Element ;
        scotch:hadFeature ?x }
```

The opportunity to consult a selection of representations of the artefact in its context may offer a range of hypotheses that the researcher can use as inspiration, source, or starting point for further investigation. As highlighted previously, the data produced with SCOTCH are very unlikely to be complete and to gather all possible representations of a certain object. However, the tool remains useful, especially in an hypothetical scenario in which several contributors enrich the available data.

Hypothetical user case#2: Re-use and citation of existing 3D elements

A second hypothetical user case for the SCOTCH framework may involve 3D experts that work in academic contexts. In an ideal scenario, where several 3D models (sometimes reproducing the same object from different perspectives and according to different hypotheses) have been documented with SCOTCH (or anything compatible with the suggested framework), researchers working with 3D technologies could usefully query the existing 3D models, and their documentation, as part of the preliminary research around the object they want to represent. Using the URI of the object they are interested in (minted by the Pleiades Gazetteer or GeoNames in case of ancient buildings, or by other authorities) to gather all variant visualisations, researchers could access a number of previous representations of the same referent, in both 2D and 3D. Accessing a number of 2D representations, as we have seen in the previous example, can corroborate the bibliographical and iconographical research that always precedes accurate 3D visualisations. Accessing other 3D visualisations, however, may offer a number of additional insights:

- If 3D authors plan to build a digital model *ex novo*, they can compare solutions adopted by other colleagues and analyse them at different levels of granularity, from the entire

building to the single 3D element. Even though nothing can guarantee complete homogeneity of documentation from different users, a 3D author can access not only the outcome produced by other researchers, but also, via the documentation, investigate the motivations of their choices, better understanding the rationale behind the final look of the model.

- Not only a user can consult the documentation that other colleagues have produced for their models and analyse their sources, but also, if the 3D authors have made their models downloadable – or at least visible – in their source format, the user could discover how other 3D authors have approached common modelling issues. For example, they could look at how many components (scotch:Components) make up a spatial element (scotch:Spatial_Element), looking for all the entities that are connected to it via the scotch:hasComponent relationship. There are a number of ways the same object can be 3D modelled, depending, for example, on the chosen software, the author’s modelling style, or the purpose of the final outcome. However, looking at someone else’s choice and discovering how they have approached a modelling problem might prove useful, especially for beginner modellers.

“Find me all the components related to a specific spatial element, SpaceA.”
<pre> PREFIX scotch: <http://www.semanticweb.org/david/ontologies/2016/7/SCOTCH#> PREFIX dc: <http://purl.org/dc/elements/1.1/> SELECT ?cmp WHERE { ?cmp a scotch:Components; scotch:isComponentOf scotch:SpaceA } </pre>

In addition, the use of SCOTCH addresses an issue that has so far proven very problematic in 3D environments: the citation and re-use of other scholars’ work, as is common practice in other disciplines. The citation and re-use can potentially happen at different degrees. For example, an entire 3D model of the Iseum could be downloaded, with attribution, and used as part of a new 3D model that seeks to represent a wider area, such as the so-called triangular forum. Likewise, a portion of an existing 3D model, such as the Iseum’s Purgatorium in either the Iseum79 or the IseumGT visualisation, could be used as a canvas or starting point for a new 3D model that focusses on the Purgatorium only, and adds many more details and/or textures, lighting or simulations. In both cases, a 3D author may want to use some pre-existing elements made by another author, and build on them, or include them within another model. Using SCOTCH makes it possible to keep track of authorship, and state the relationship of the new 3D model with one or more existing ones. This is enabled not only by the fact that, in SCOTCH, each 3D element must have a scotch:3Dcreator property, but also by the very presence of the documentation that makes a piece of 3D modelling assessable (and safe to cite). A 3D element downloaded from a 3D model, and imported into another, will be part of both models and have the same author, i.e. the original one (scotch:3Dcreator). Thus, if a user wants to discover how many 3D models have directly used and re-used a particular 3D element (scotch:Spatial_Element_3DRepresentations), they could query the SCOTCH documentation in order to find out of how many 3D visualisations it is part (dc:isPartOf).

“Find me all 3D models that include a specific 3D element, SpaceA.3DS_79, as one of their parts.”

```
PREFIX scotch: <http://www.semanticweb.org/david/ontologies/2016/7/SCOTCH#>
PREFIX dc: <http://purl.org/dc/elements/1.1/>

SELECT ?mod WHERE {
  ?mod dc:hasPart scotch:SpaceA.3DS_79
}
```

If the users are especially interested in the work of a particular 3D author, they could search within a single model (or within a group of them) for all the 3D elements (scotch:Spatial_Element_3DRepresentations) that have the name of that author (or their URI in some external authority list) as value of scotch:3Dcreator.

“Find me all the 3D elements in the dataset that have a specific author, *Valeria Vitale* (ORCID 0000-0002-9695-0240).”

```
PREFIX scotch: <http://www.semanticweb.org/david/ontologies/2016/7/SCOTCH#>
PREFIX dc: <http://purl.org/dc/elements/1.1/>
PREFIX orc: <>

SELECT ?elm WHERE {
  ?elm a scotch:Spatial_Element_3DRepresentations ;
       scotch:3Dcreator orc:0000-0002-9695-0240 }

```

If a new 3D element has been informed by the analysis of a pre-existing 3D element belonging to another 3D model, the newly created one will have a value “Derived” of scotch:hasSourceType, and will be accompanied by the mandatory property scotch:isDerivedFrom, which will point to the original 3D element. In this way, it will be possible not only to query how many times (within the models documented with SCOTCH) a 3D element has been directly re-used, but also how many times, and in what ways, that 3D element has indirectly inspired the modelling of new ones.

“Find me all the 3D elements in the dataset that have been derived from element SpaceA.3DS_79.”

```
PREFIX scotch: <http://www.semanticweb.org/david/ontologies/2016/7/SCOTCH#>
PREFIX dc: <http://purl.org/dc/elements/1.1/>

SELECT ?elm WHERE {
  ?elm a scotch:Spatial_Element_3DRepresentations ;
       scotch:sourceType scotch:derived ;
       scotch:isDerivedFrom scotch:SpaceA.3DS_79
}
```


Hypothetical user case#3: Teaching art history with SCOTCH

Assuming again that SCOTCH is a documentation framework used by multiple researchers, and that the documentation is available and cross-searchable, documented 3D models could be used as aids in the teaching of art history, and especially architecture. In such a scenario, teachers could encourage their students to query the documentation of 3D models in order to gain a better understanding of the buildings they represent, and to compare architectural influences in different periods of time. For example, the potential of SCOTCH could be exploited to investigate the popularity of Vitruvian standards in ancient times, and compare the results with those for the neoclassical period. The students should then select documented 3D models representing buildings belonging to two categories: ancient Greek and Roman times, and neoclassical.

In an hypothetical scenario where the SCOTCH framework is more widely used, a teacher could ask their students to look for all the spatial elements in ancient buildings that seem to follow Vitruvian standards. They would then repeat the same exercise for neoclassical buildings which follow the same rules, and compare the results. The exercise could be divided into (at least) three steps. First, the student could query the examples of documented 3D visualisations of ancient buildings to isolate the 3D components (scotch:Components) based on a primary source (scotch:hasSourceType, scotch:Primary) that also has the property of being supported (scotch:isSupportedBy) by another source. Among the results, students would select those 3D components that are supported by the Vitruvian Books of Architecture. The operation should then be repeated for the 3D visualisations of neoclassical buildings.

“Find me all the 3D components in the dataset that are based on a primary source AND are supported by another reference.”

```
PREFIX scotch: <http://www.semanticweb.org/david/ontologies/2016/7/SCOTCH#>
SELECT ?comp ?src ?ref WHERE {
    ?comp a scotch:Components ;
    scotch:source ?src .
    ?src a scotch:primaryType ;
    scotch:isSupportedBy ?ref .
    ?ref a scotch:SecondaryType }
```

After researching the elements that appear to be supported by Vitruvian standards in both ancient and neoclassical architecture, the students could use the information gathered to discuss aspects of the buildings that now appear more clearly. For example, they could look at which elements seem compatible most often with the Roman architect's standards, how they relate to the other architectural components, how the elements and their contexts changed over the centuries, and even how such examples are geographically distributed (at least in the selected examples).

The third step of the exercise would be to look for those ancient buildings that have spatial elements that are not standing anymore, where the authors of the related 3D representations have used Vitruvian standards to supply the missing information. The query should then be designed to identify all 3D components (scotch:Components) in the representation of the ancient buildings that are based (scotch:hasSourceType) on an educated guess and, in particular, on an existing canon (scotch:guessed, scotch:canon). The students should then manually select those examples that specifically refer to Vitruvius.

“Find me all the 3D elements in the dataset that are based on a well established canon”

```
PREFIX scotch: <http://www.semanticweb.org/david/ontologies/2016/7/SCOTCH#>
PREFIX dc: <http://purl.org/dc/elements/1.1/>

SELECT ?elm ?src WHERE {
  ?elm a scotch:Components ;
       scotch:hasSourceType scotch:canon ;
       scotch:source ?src }
```

The three steps of the exercise would invite the students to reflect on three main topics related to historical architecture: how often surviving ancient buildings seem to apply the canon indicated by Vitruvius; how often in 3D reconstructions of ancient buildings the missing information is calculated based on Vitruvius' books; and how often, during Neoclassicism, Vitruvius was adopted as a model by contemporary architects. The comparison between these data, even though partial and incomplete, could lead the students to reflect on the idea of architectural practices and the reception of buildings at different points in history.

Adding supporting resources for each statement in the documentation is not mandatory, and in many cases simply impossible. From this perspective, the exercise suggested is likely to give relevant results only if the documentation framework has been used at the peak of its potential. On the other hand, students of ancient art and architecture could themselves be involved in implementing the SCOTCH documentation of 3D visualisations, adding supporting references (scotch:isSupportedBy), for example, when the measurements of 3D elements seem to match a particular canon (in our case, Vitruvius').

Appendix E. Metadata

The removable USB support, attached to this thesis contains the following files:

Iseum79.3DS

authors: Valeria Vitale, with contributions by Drew Baker

Date of creation: 2017

Software: Autodesk 3DS Max 2014

The file can only be read with Autodesk 3DS Max

IseumGT.3DS

author: Valeria Vitale

Date of creation: 2017

Software: Autodesk 3DS Max 2014 for the model, Adobe Photoshop (C4 version) for the textures. The 3D file and all the associated textures have been saved through the Autodesk 3DS Max function "archive".

The file can only be opened with Autodesk 3DS Max

Iseum79.OBJ

.OBJ has been chosen as standard exchange format for 3D files

author: Valeria Vitale

Date of creation: January 2017

Software: Autodesk 3DS Max 2014

The file can be read with with a number of 3D software including: Autodesk 3DS Max, Blender, Sketchup, Cinema 4D

IseumGT.OBJ

author: Valeria Vitale

Date of creation: January 2017

Software: Autodesk 3DS Max 2014

The file can be read with with a number of 3D software including: Autodesk 3DS Max, Blender, Sketchup, Cinema 4D

SCOTCH.owl

author: Valeria Vitale

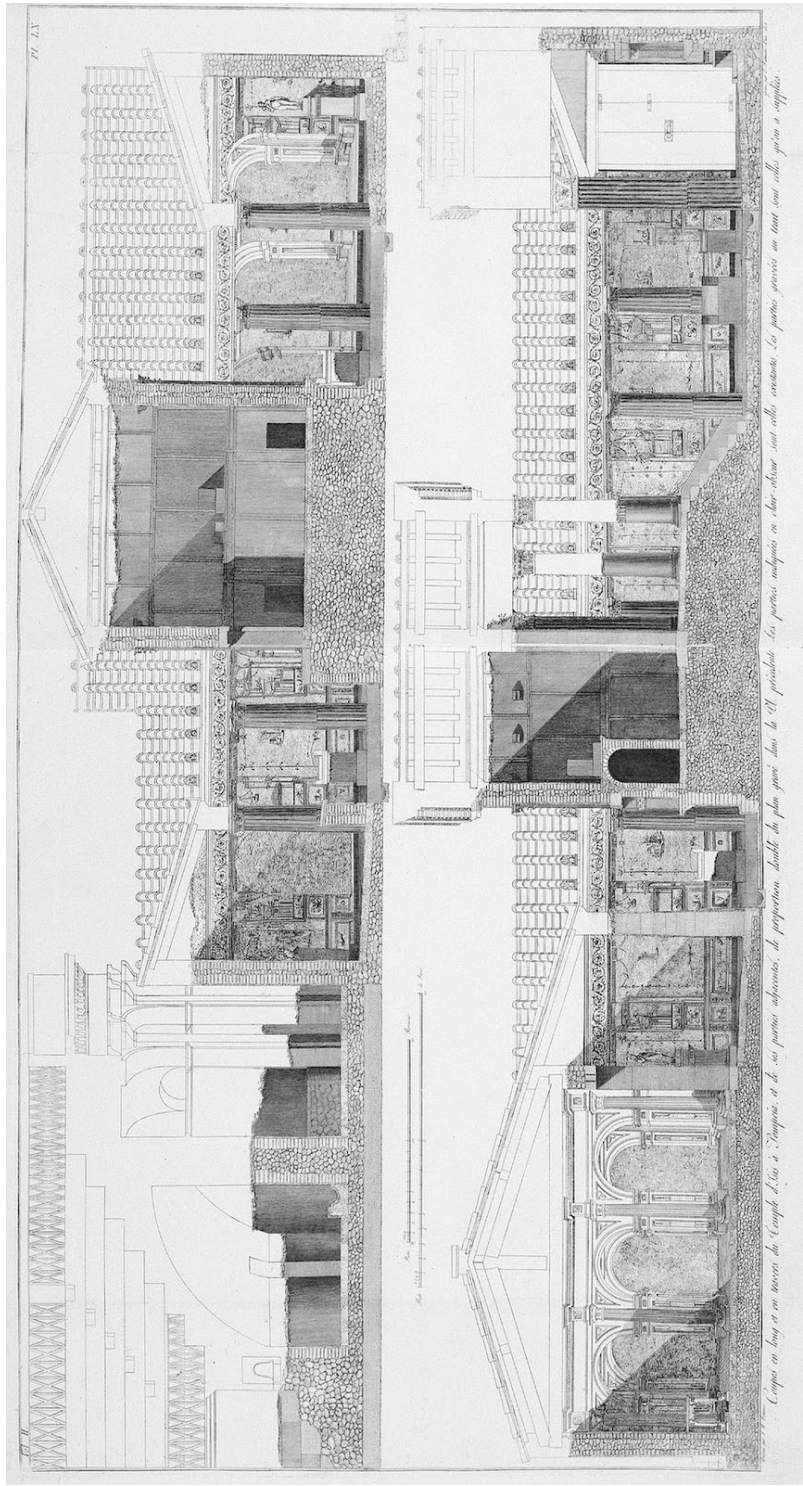
Date of creation: 2016

Software: Protege 5 (Windows version)

The file can be read by several RDF editors, but it has been tested only on Protege. To visualise all the inferred properties, it is recommended to activate the Reasoner Hermit 1.3.8.414

Photographs and videos that have been used as evidence, transcriptions of the measurements, textures are available online at the Flickr account: <https://www.flickr.com/photos/134064462@N06/albums>

Appendix F. Selected Depictions of the Iseum in Pompeii



1. Piranesi G. B. (illustrator), Piranesi, F. (etcher). (1806) Coupes en long et en travers du Temple d'Isis à Pompeia. et de ses parties adjacentes, de proportion double du plan gravé dans la Pl. précédente. Les parties indiquées en clair-obscur sont celles existantes. Les parties gravées au trait sont celles qu'on a suppléées. Paris. In Piranesi F., Antiquités de la Grande Grèce aujourd'hui Royaume de Naples. ..., Piranesi frères, 1804 - 1807, vol. II, Tav. L. Digital copy for non commercial purposes.



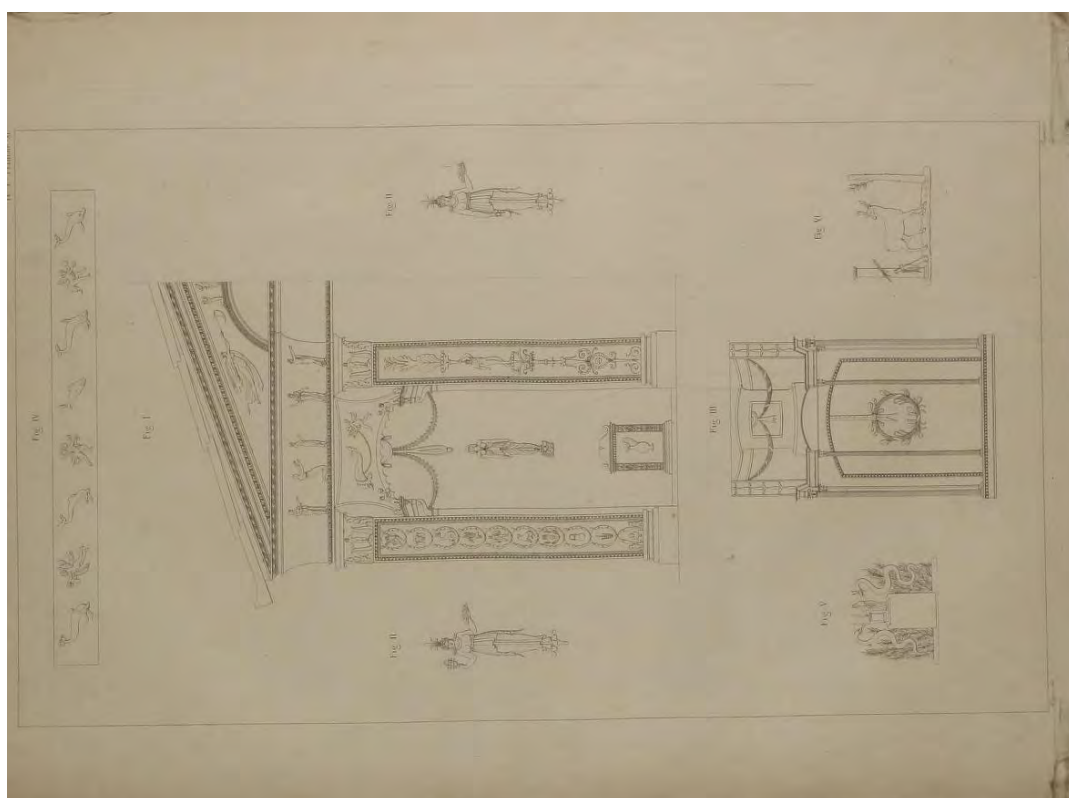
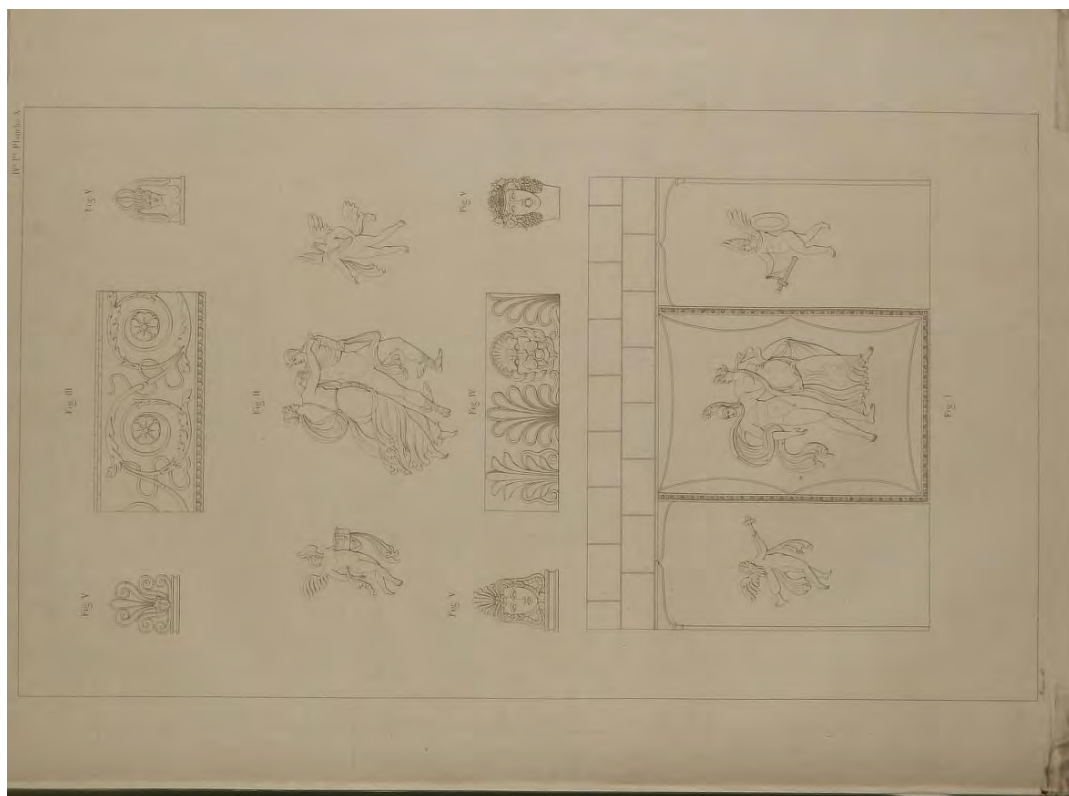
2. Desprez, J.L. (illustrator) & Berthault, P.G. (etcher), Vue du temple d'Isis a Pompeii prise sur la partie laterale et retabli tel qu'il devoit etre avant l'Eruption de 79. In Saint Non (abbé de) J., Voyage pittoresque ou description des royaumes de Naples et de Sicile. Seconde partie du premier volume... Les Antiquités de Pompéii, Clousier, 1782, vol. I, Tav. 75. Digital copy for non commercial purposes.



3. Desprez, J.L. (illustrator) & Dagoly fils (etchers) Temple d'Isis à Pompeii tel qu'il devoit être en l'Année 79. lorsqu'il a été détruit par l'éruption du Vesuve; et rétabli d'après et suivant ce qui en existe encore aujourd'hui. In Saint Non (abbé de) J., Voyage pittoresque ou description des royaumes de Naples et de Sicile. Seconde partie du premier volume... Les Antiquités de Pompéii, Clousier, 1782, vol. I, Tav. 75 bis. Digital copy for non commercial purposes.



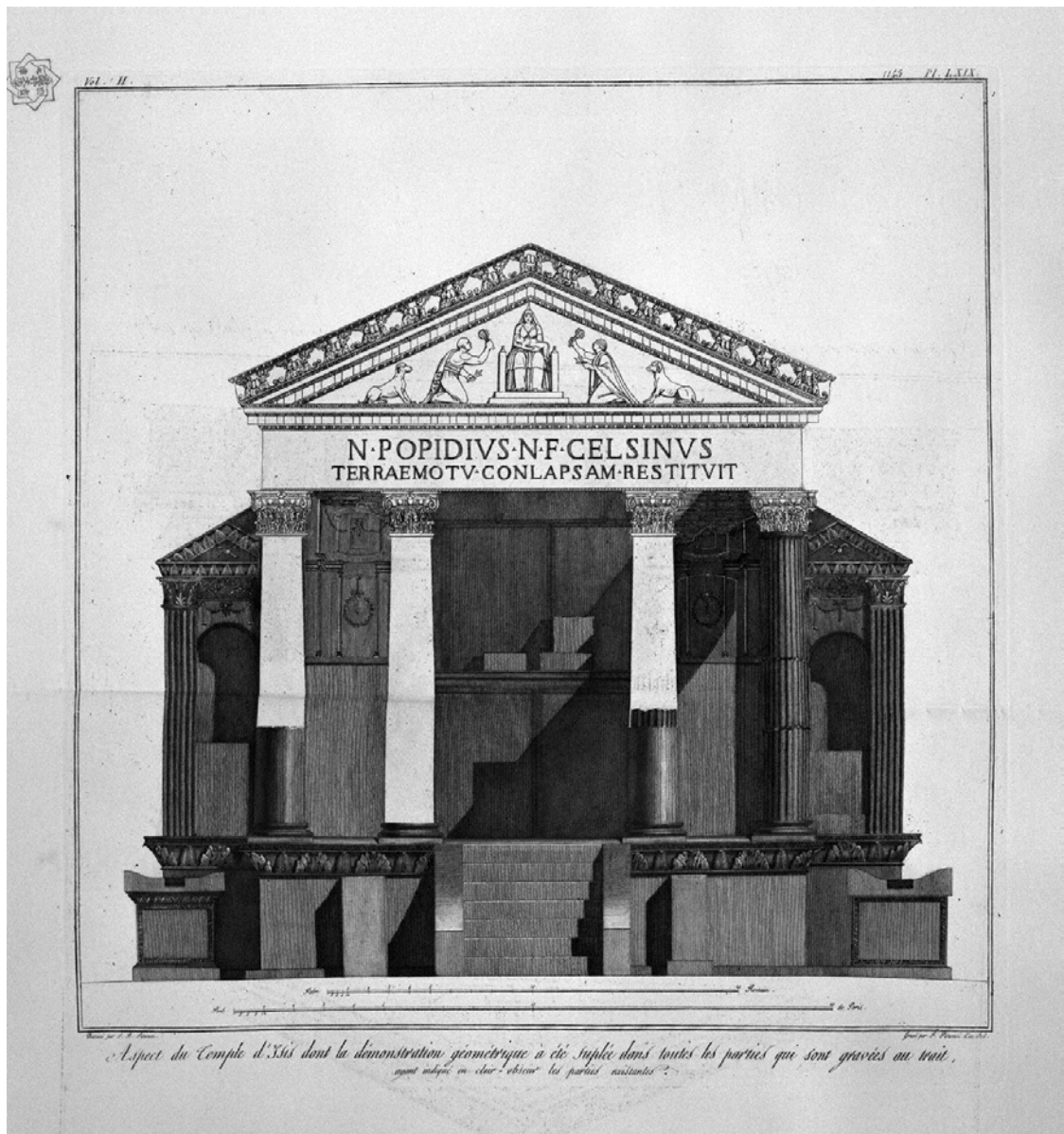
4. Piranesi G. B. (illustrator), Piranesi, F. (etcher). (1806) Démonstrations géométriques de la porte de l'enceinte du temple d'Isis, avec ses valves ou battans de bois à trois parties qui la fermaient. In: Piranesi F., Antiquités de la Grande Grèce aujourd'hui Royaume de Naples..., Piranesi frères, 1804 - 1807, vol. II, Tav. LXII. Public Domain. Source:Wikiart.



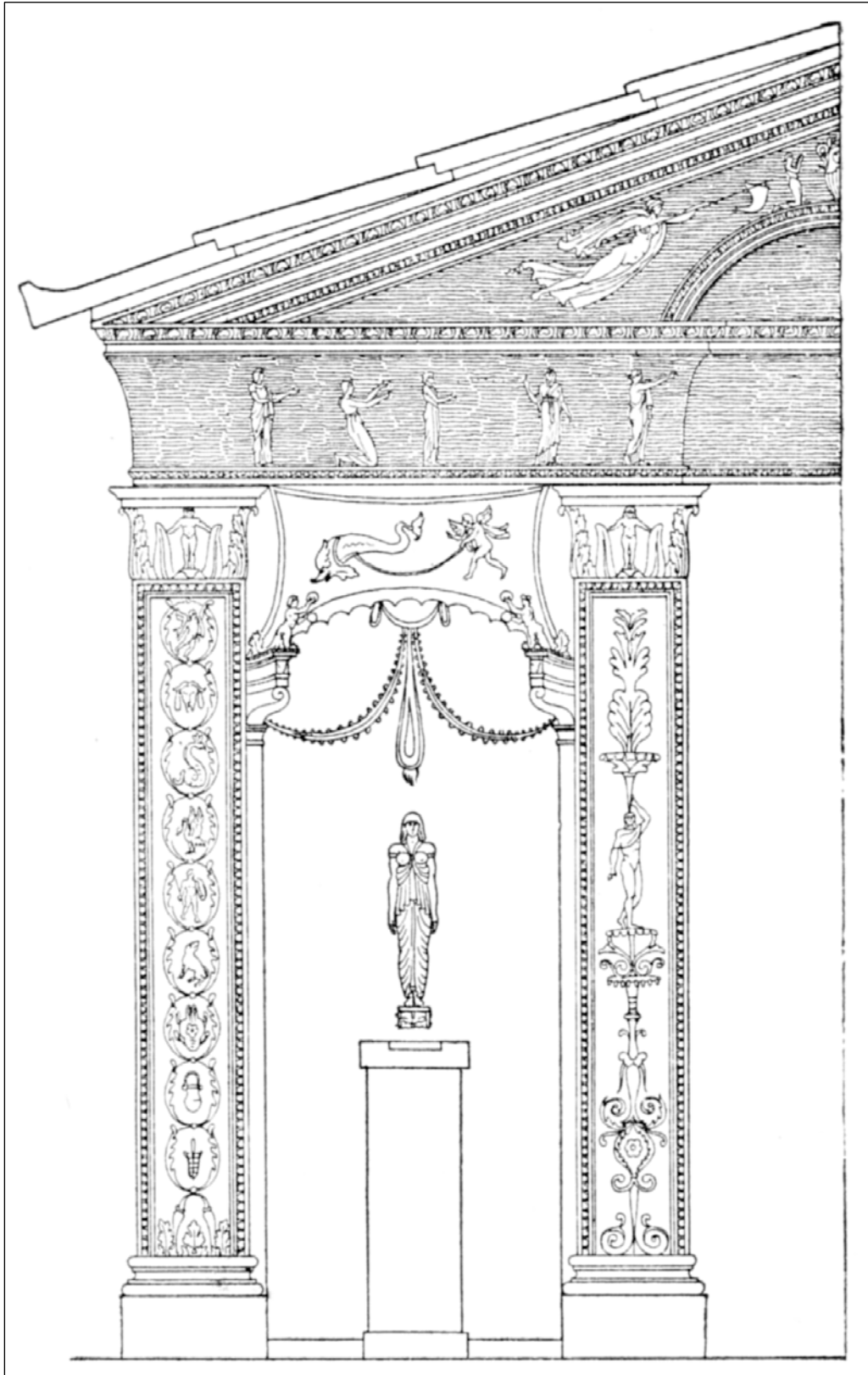
5. 6. Mazois, F (illustrator) & Bigant (etcher). Tempio di Iside, decorazione architettonica, stucchi - prospetti. In Mazois F., *Les Ruines de Pompéi, dessinées et mesurées par F. Mazois, pendant les années MDCCCIX, MDCCCX, MDCCCXI...* (ouvrage continué par M. Gau), Parigi, 1812 - 1838, vol. IV, Tav. XI. Public Domain. Source: archive.org



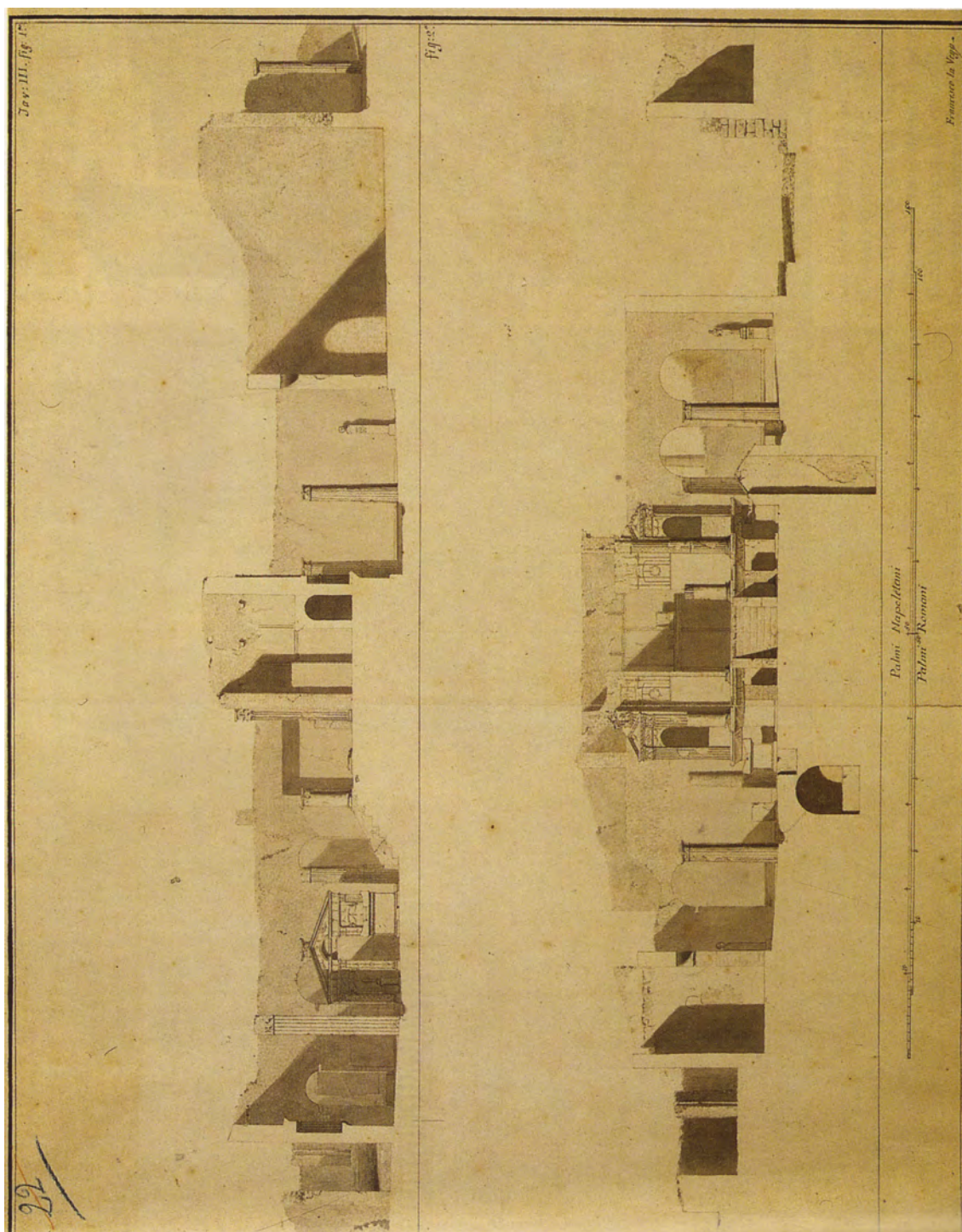
7. Leroux, L. H. Ceremony in the Temple of Isis. Published in *Pompei e L'Europa* 1748-1943. Electa 2015. Digital copy for non commercial purposes.



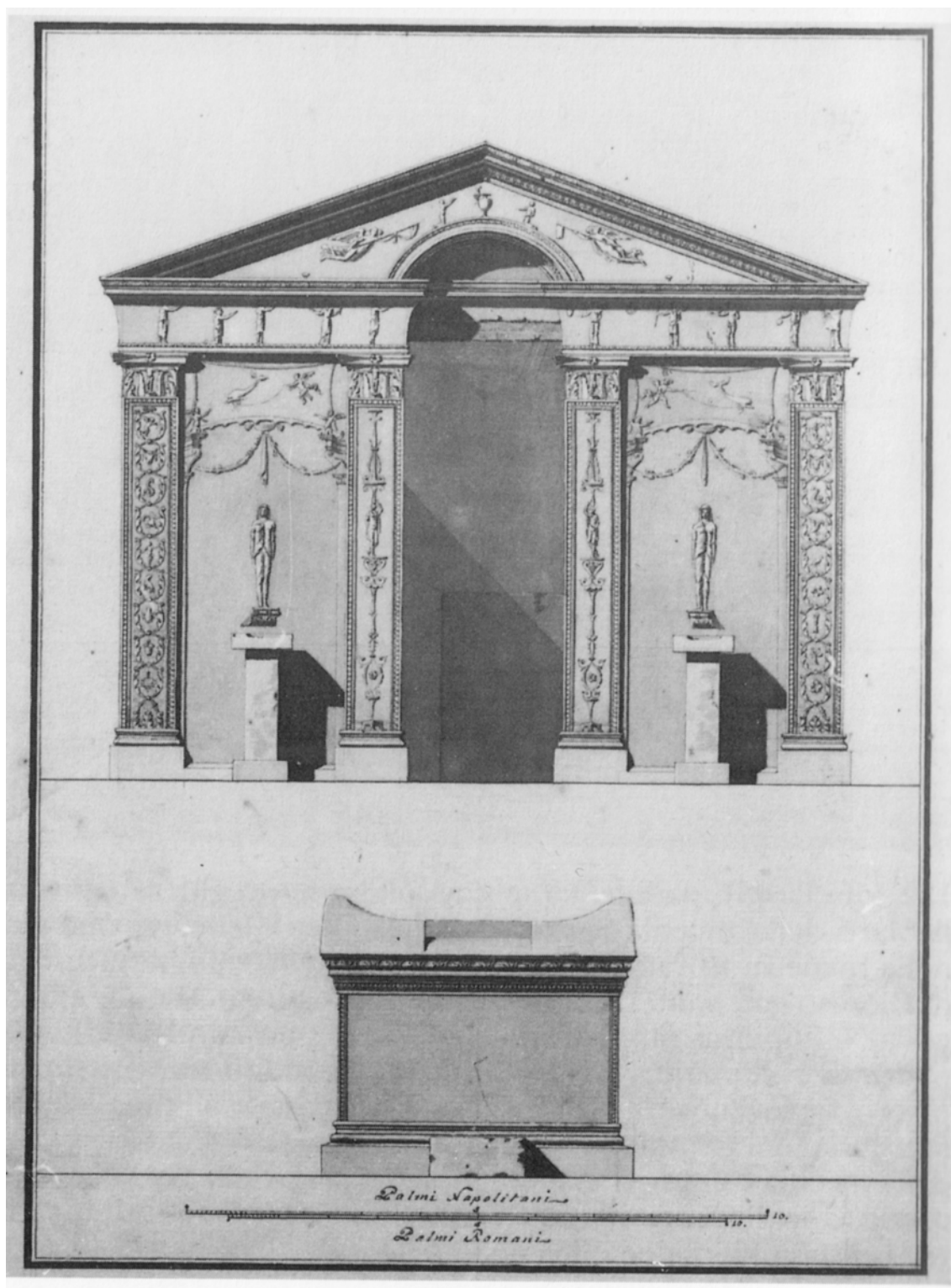
8. Piranesi G. B. (illustrator), Piranesi, F. (etcher). Aspect du Temple d'Isis dont la démonstration géométrique a été supplée dans toutes les parties qui sont gravées au trait, ayant indiqué en clair-obscur les parties existantes. In Piranesi F., *Antiquités de la Grande Grèce aujourd'hui Royaume de Naples...*, Piranesi frères, 1804 - 1807, vol. II, Tav. LXIX. Public domain. Source: wikimedia art.



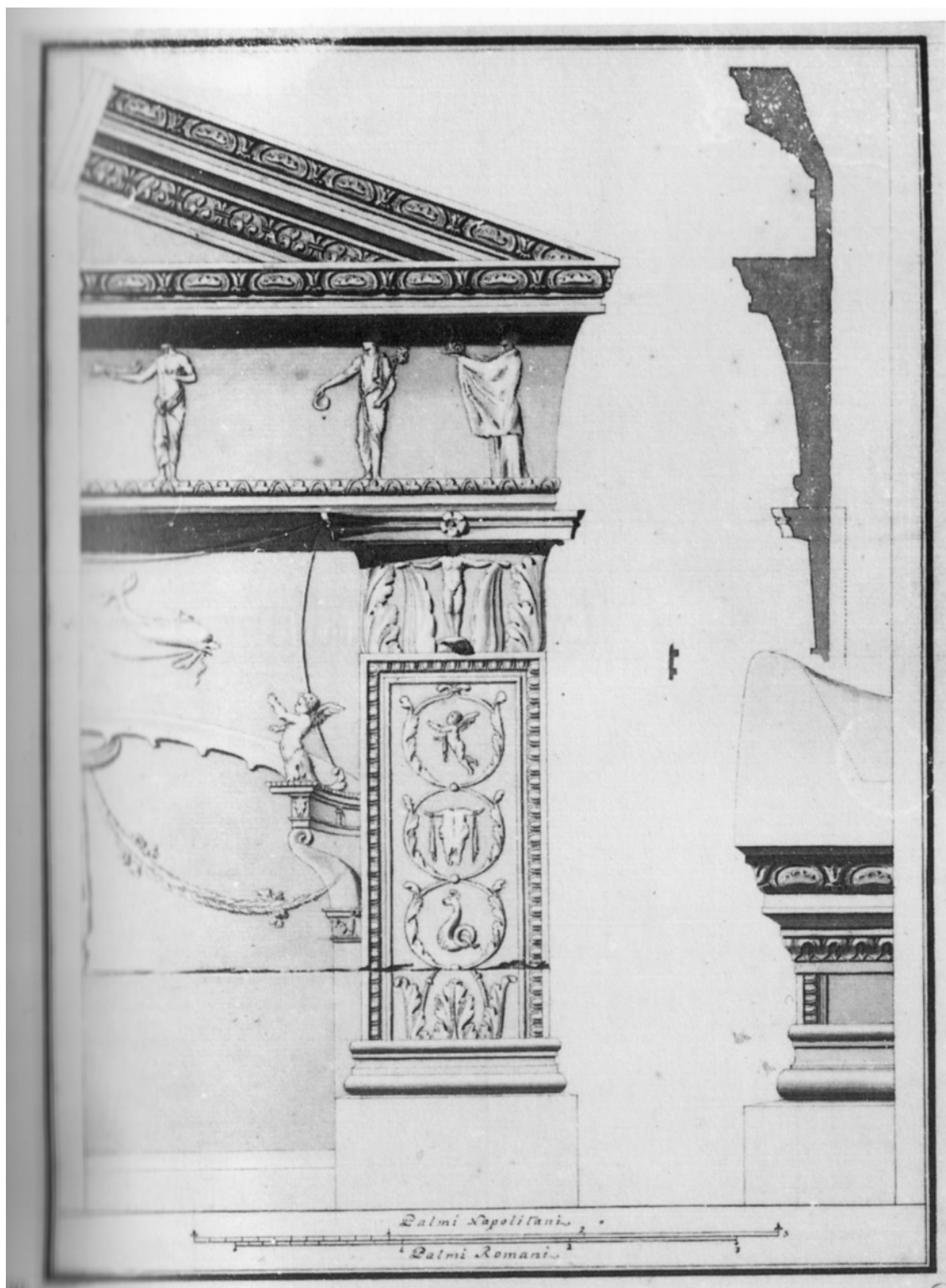
9. A. Mau, A. 1899. Part of the Façade of the Purgatorium. In *Pompeii: its life and art*. London : Macmillan & Co. Digital copy for non commercial purposes.



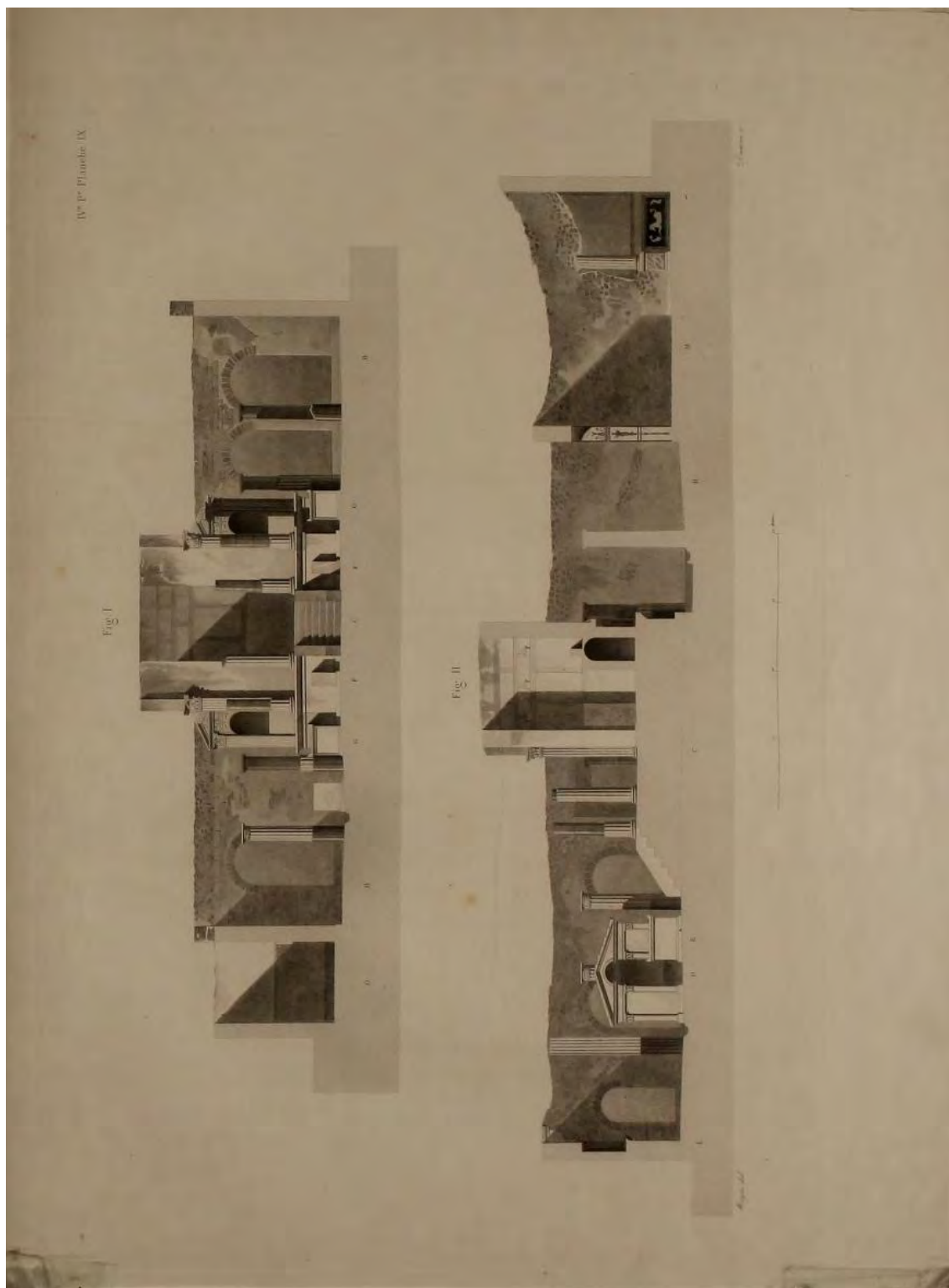
10. Francesco La Vega, 1764-6. Elevation and cross section of the Iseum. Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. Pompei pitture e mosaici. Roma : Istituto della enciclopedia italiana. Digital copy for non commercial purposes.



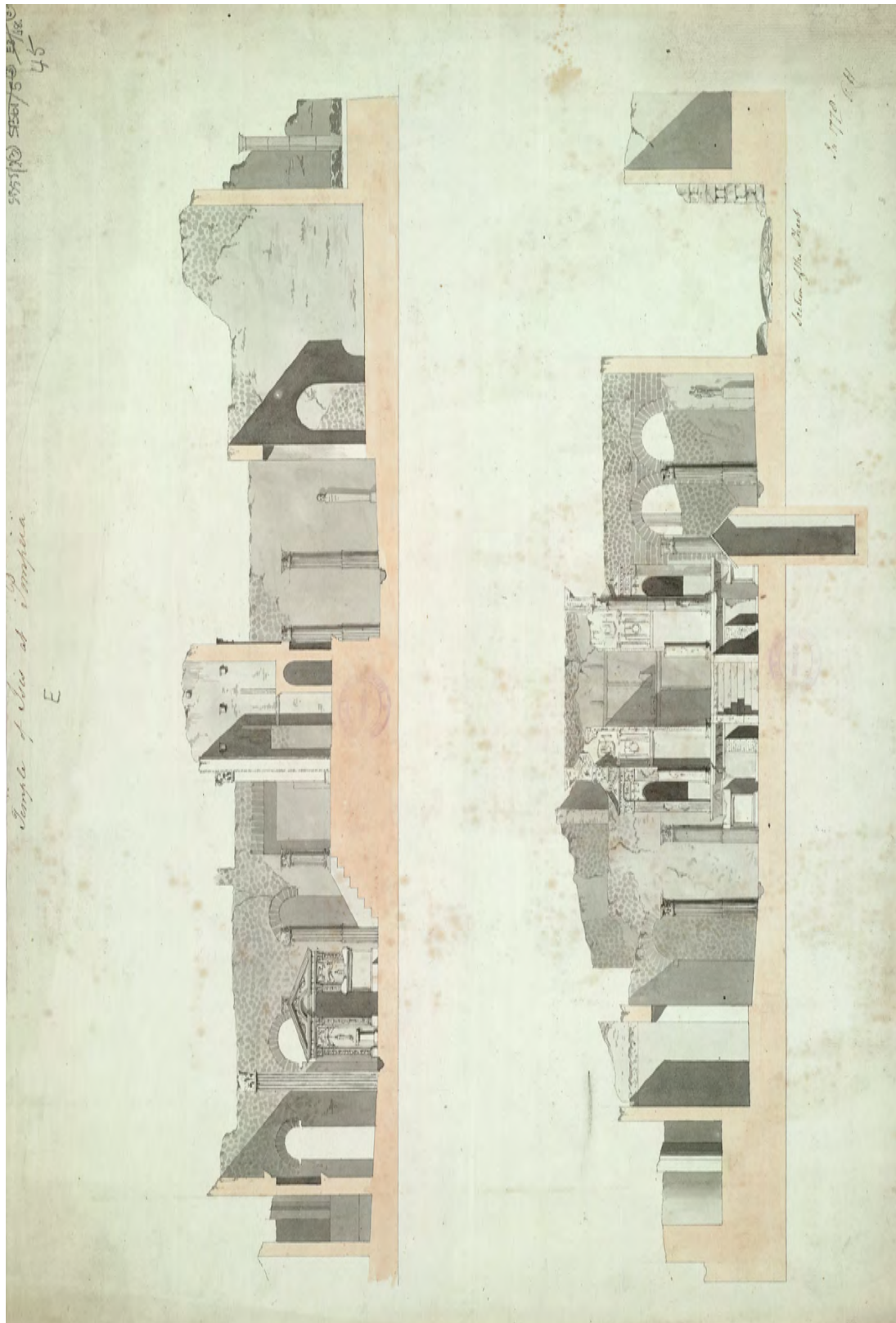
11. La Vega, F. (illustrator), Nolli, C. (etcher). Purgatorium. Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. Pompei pitture e mosaici. Roma : Istituto della enciclopedia italiana. Digital copy for non commercial purposes.



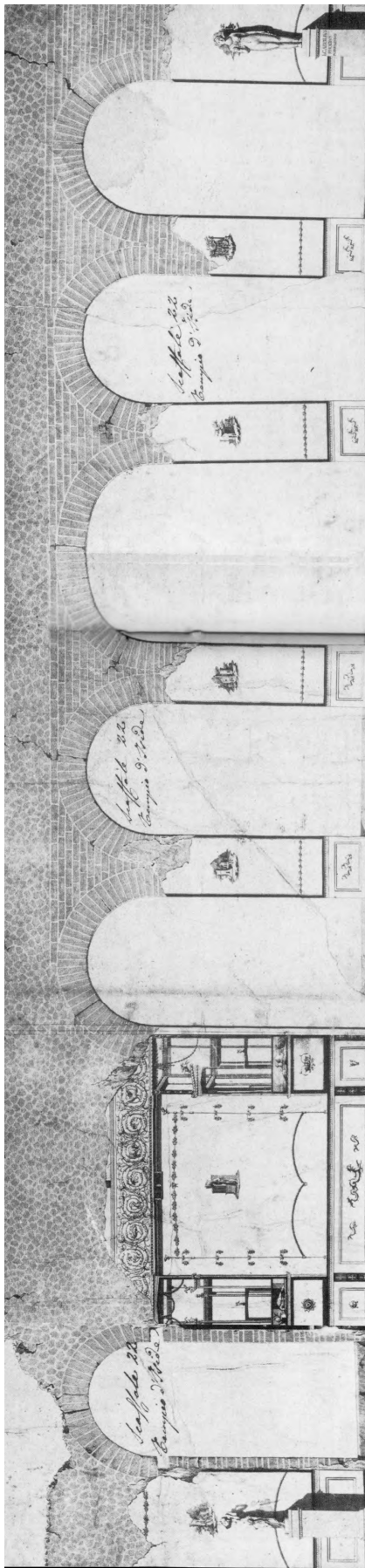
12. La Vega, F. (illustrator), Nolli, C. (etcher). Purgatorium, particolari. Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. Pompei pitture e mosaici. Roma : Istituto della enciclopedia italiana. Digital copy for non commercial purposes.



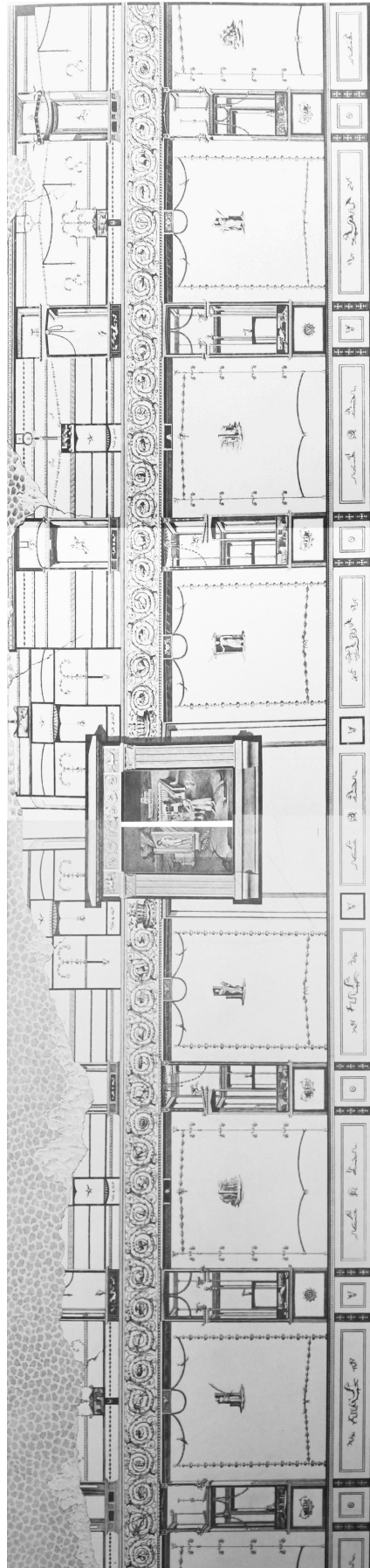
13. Mazois, F. (illustrator) & Dormier A.C (etcher) Tempio di Iside - prospetto, sezione. In: Mazois F., Les Ruines de Pompéi, dessinées et mesurées par F. Mazois, pendant les années MDCCCIX, MDCCCX, MDCCCXI... (ouvrage continué par M. Gau), Parigi, 1812 - 1838, vol. IV, Tav. IX Public Domain. Source: archive.org



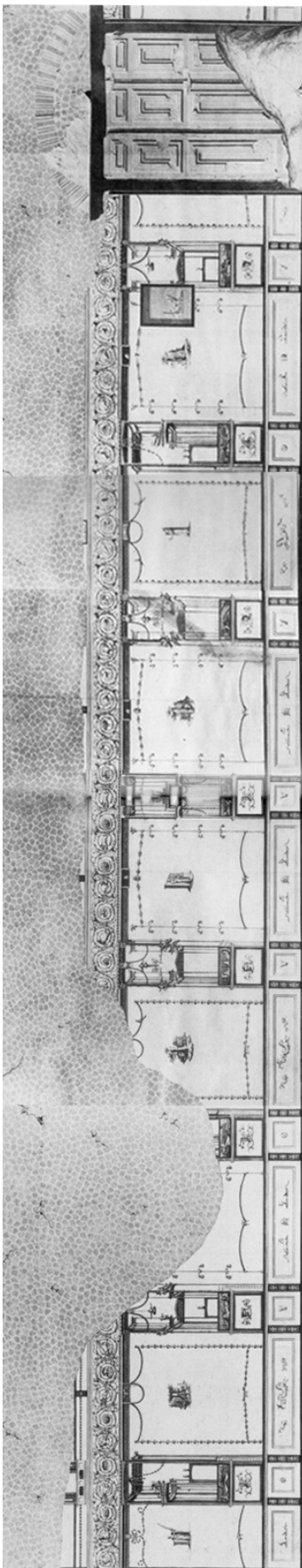
14. Hardwick, Thomas (1752-1829), Measured drawings of the Temple of Isis, Pompeii: sections 1778 RIBA Collections. Courtesy of RIBA for non commercial purposes.



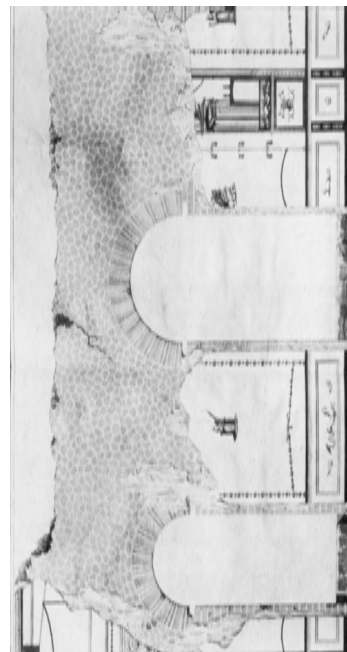
15. Casanova, G. (illustrator) & A. Cattaneo (etcher), Portico Ovest. in Avellino, F. M. 1851. Il Tempio di Iside. Napoli. Published in De Caro, S. (ed) 1992. *Alla ricerca di Iside : analisi, studi e restauri dell'Iseo pompeiano nel Museo di Napoli*. Digital copy for non commercial purposes.



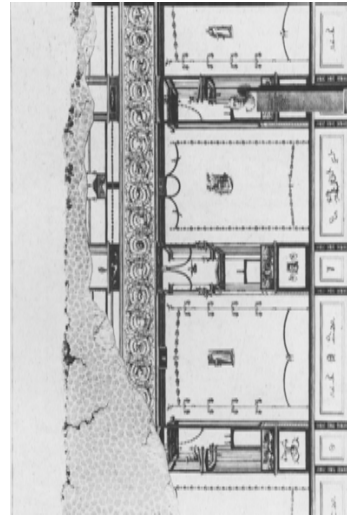
16. Casanova, G. (illustrator) & A. Cattaneo (etcher), Portico Est. in Avellino, F. M. 1851. Il Tempio di Iside. Napoli. Published in Elia, O. 1941. *Le pitture del Tempio di Iside*. Roma. Digital copy for non commercial purposes.



17. Casanova, G. (illustrator) & A. Cattaneo (etcher), Portico Nord. in Avellino, F. M. 1851. Il Tempio di Iside. Napoli. Published in De Caro, S. (ed) 1992. *Alla ricerca di Iside : analisi, studi e restauri dell'Isseo pompeiano nel Museo di Napoli*. Digital copy for non commercial purposes.



18. Casanova, G. (illustrator) & A. Cattaneo (etcher), Portico Sud. Rami occidentale e orientale. in Avellino, F. M. 1851. Il Tempio di Iside. Napoli. Published in De Caro, S. (ed) 1992. *Alla ricerca di Iside : analisi, studi e restauri dell'Isseo pompeiano nel Museo di Napoli*. Digital copy for non commercial purposes.

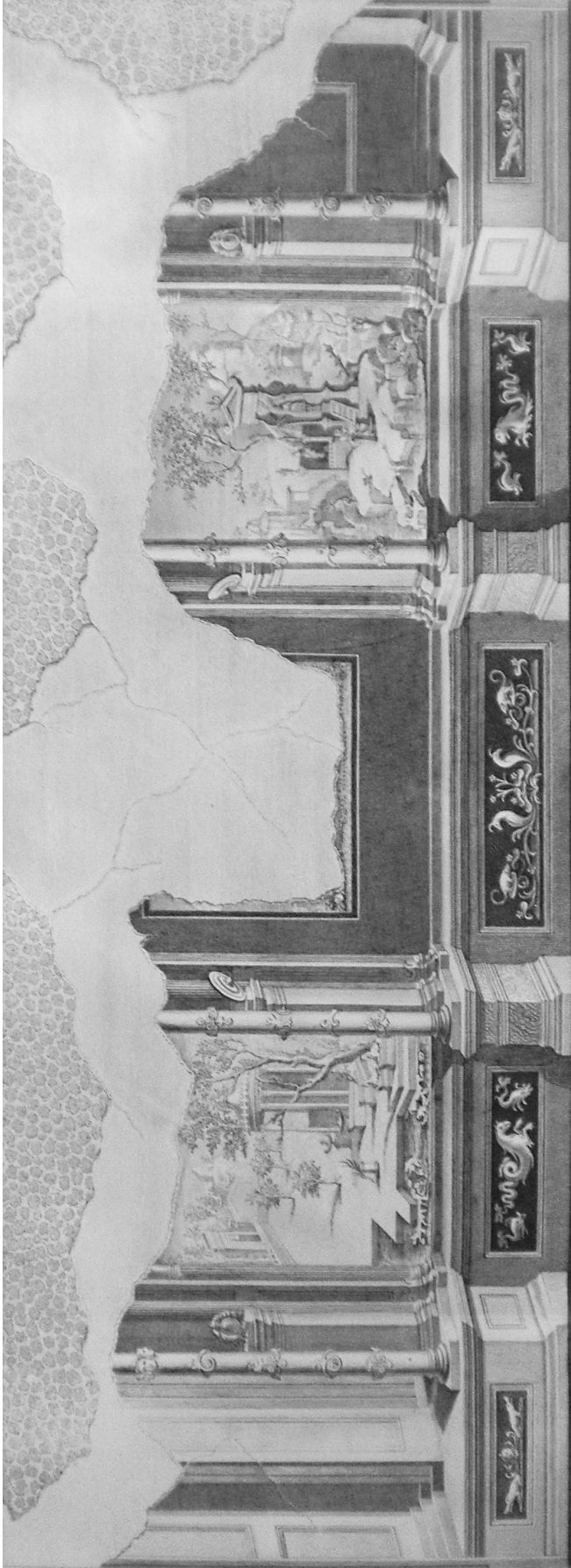




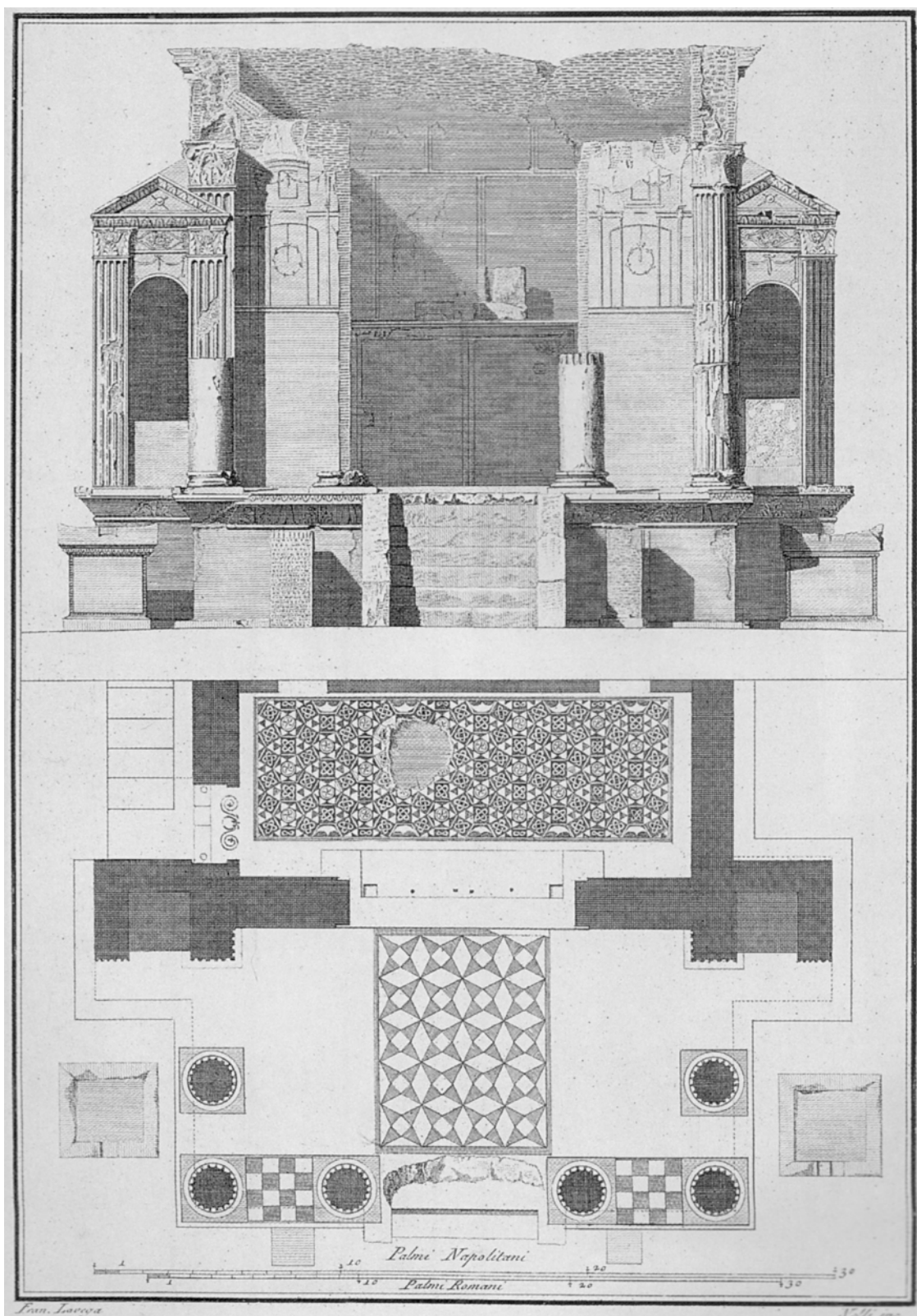
19. Chiantarelli, G. (illustrator) & Cattaneo, A. (etcher) South wall of the ekklesiasterion in the Temple of Isis in Pompeii. Published in Elia, O. 1941. *Le pitture del Tempio di Iside*. Roma. Digital copy for non commercial purposes.



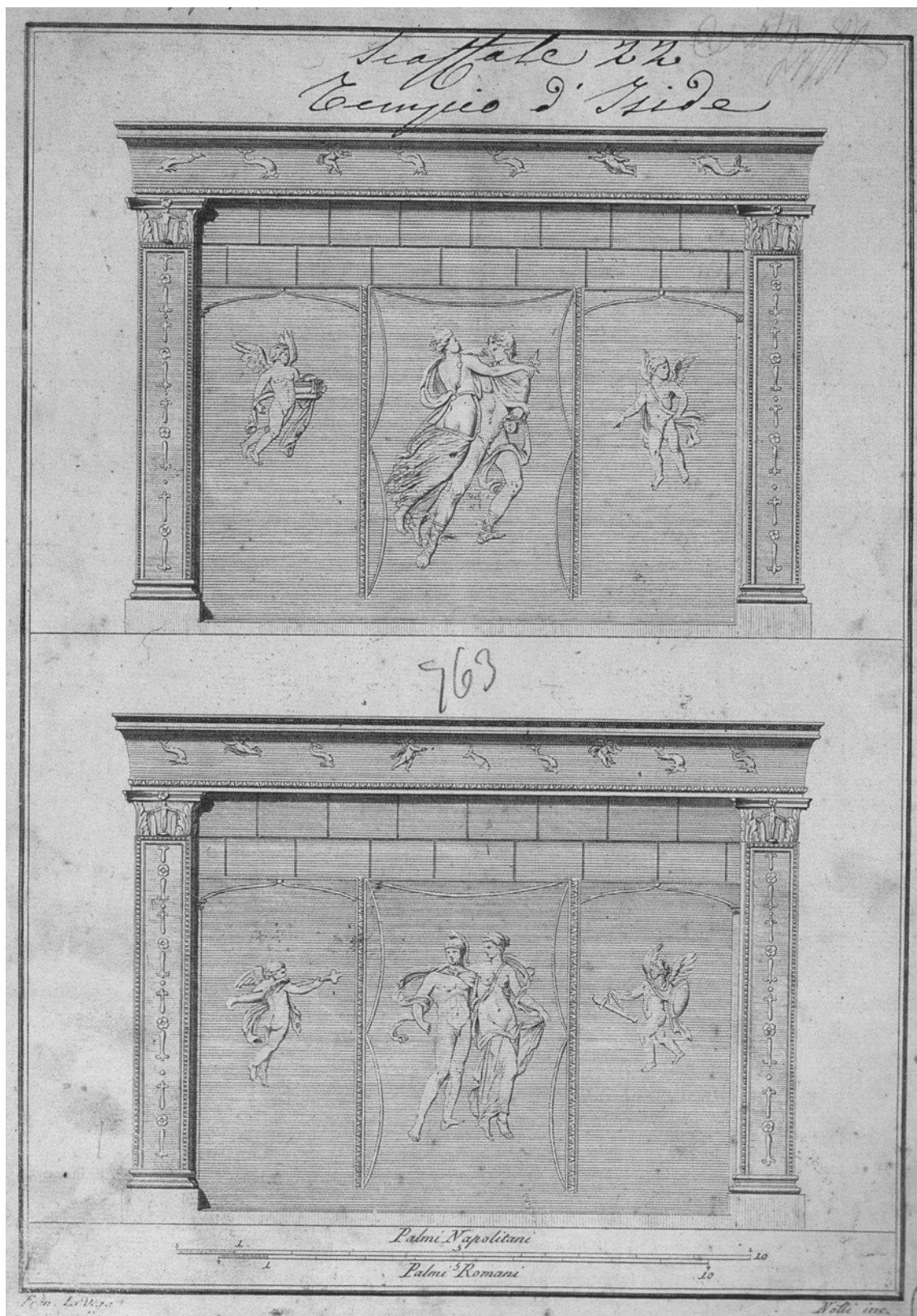
20. Morghen, G. (illustrator) & A. Casanova (etcher) North wall of the ekklesiasterion in the Temple of Isis in Pompeii. Published in Elia, O. 1941. *Le pitture del Tempio di Iside*. Roma. Digital copy for non commercial purposes.



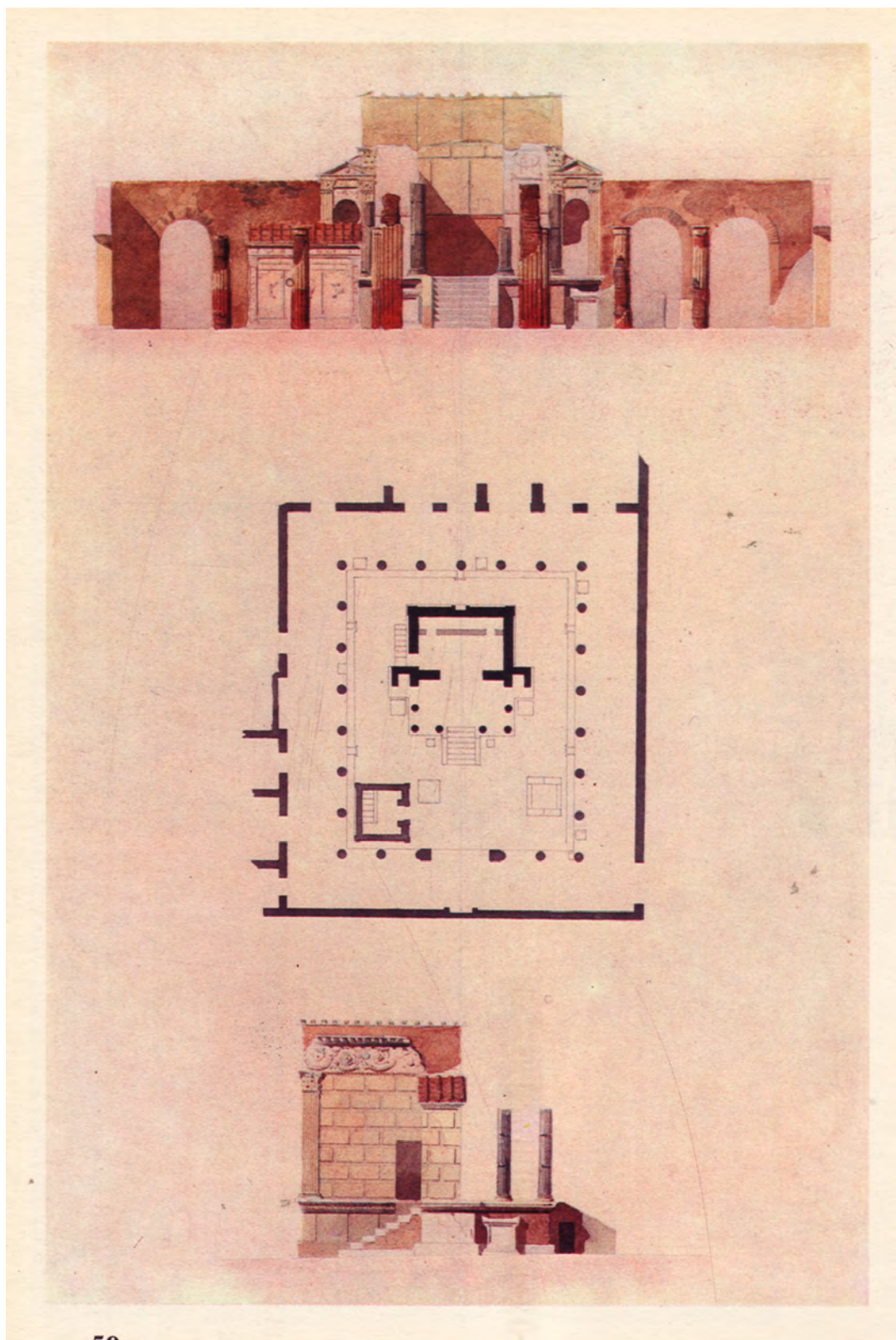
21. Chiantarelli, G. (illustrator) & A. Cattaneo (etcher) West wall of the ekklesiasterion in the Temple of Isis in Pompeii. Published in Elia, O. 1941. *Le pitture del Tempio di Iside*. Roma. Digital copy for non commercial purposes.



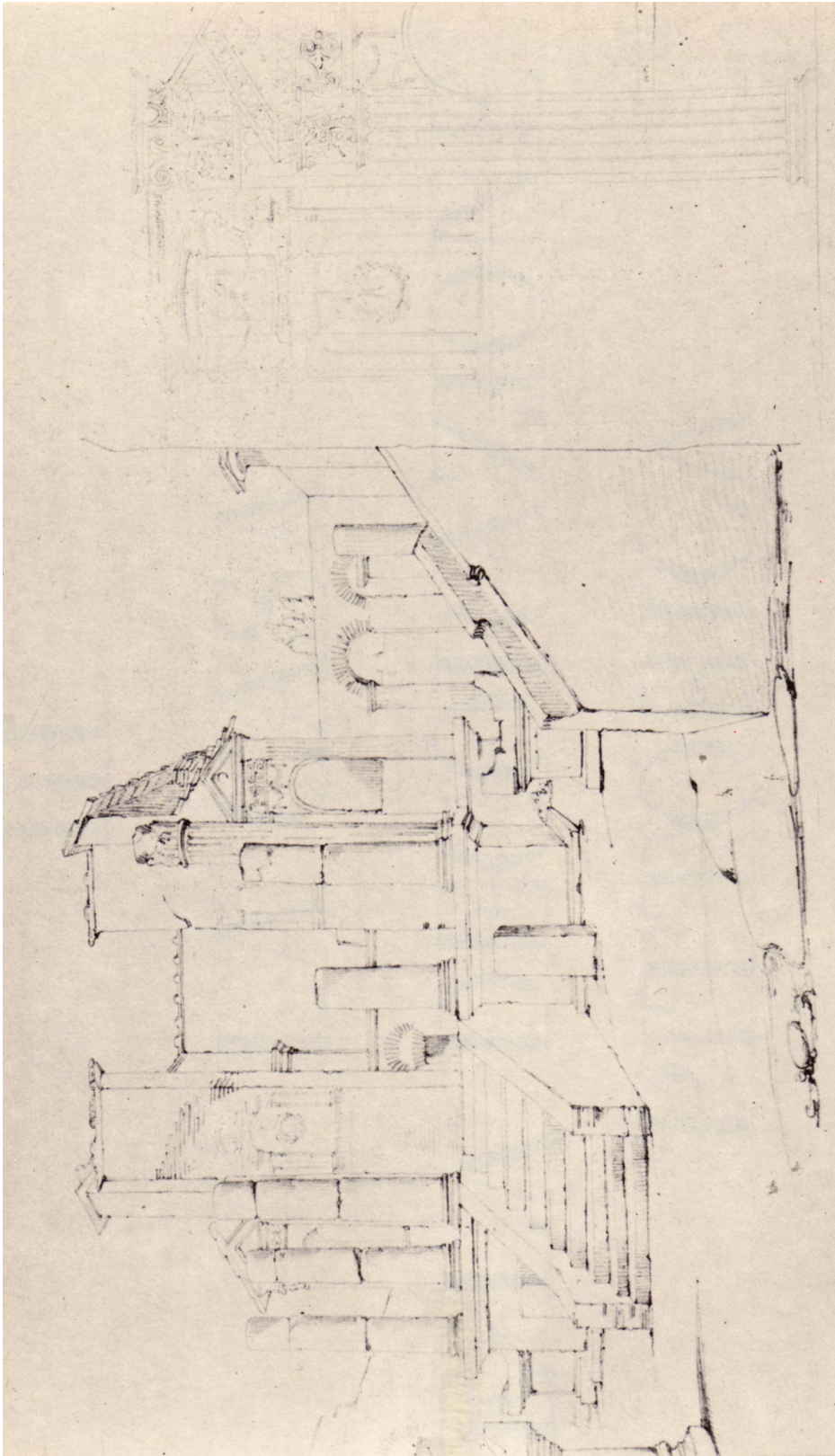
22. La Vega, F. (illustrator), Nolli, C. (etcher). Pronao. Pianta e Prospetto. Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. Pompei pitture e mosaici. Roma : Istituto della enciclopedia italiana. Digital copy for non commercial purposes.



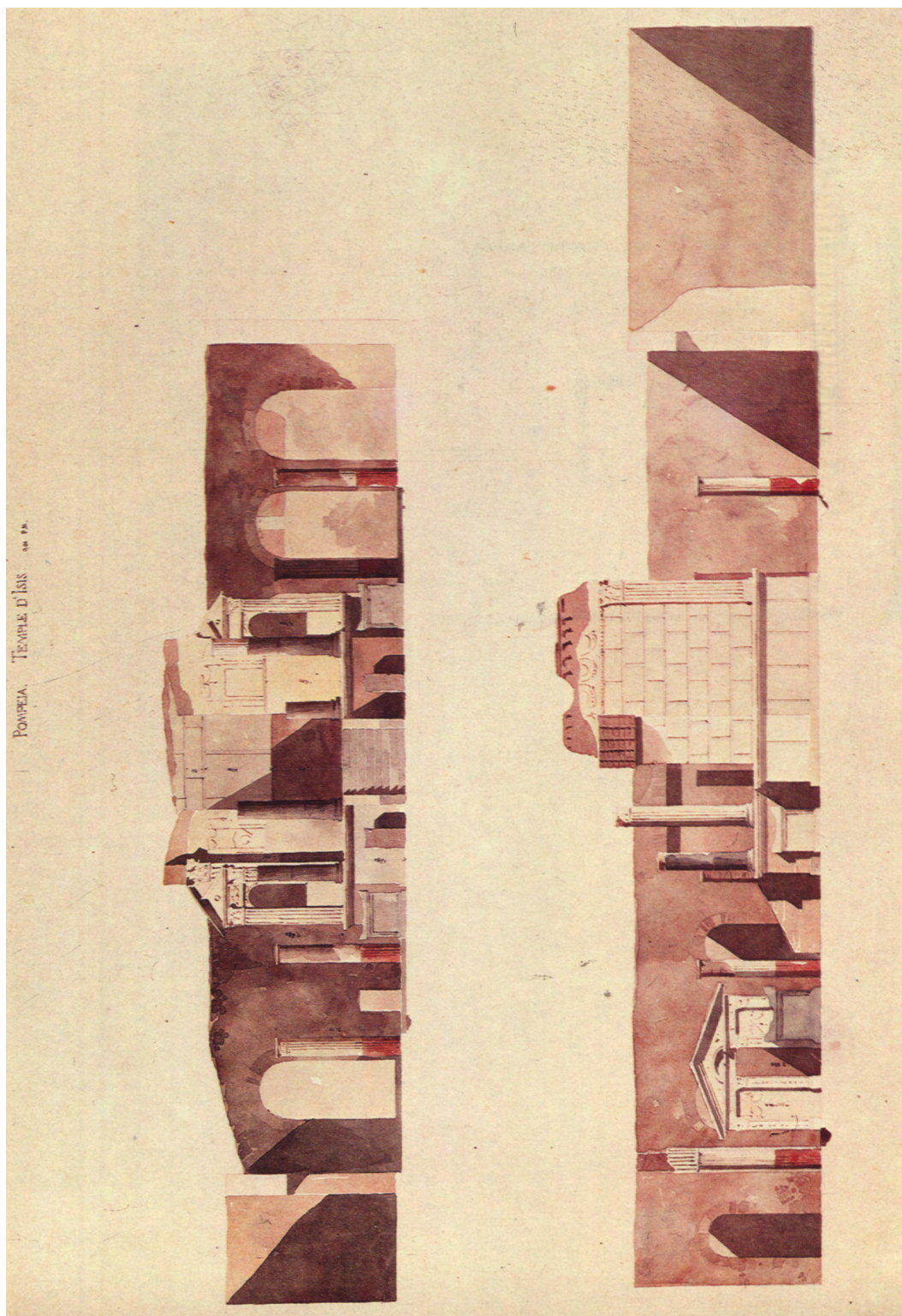
23. La Vega, F. (illustrator), Nolli, C. (etcher). Purgatorium, facciate est e ovest. Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. Pompei pitture e mosaici. Roma : Istituto della enciclopedia italiana. Digital copy for non commercial purposes.



24. Bouchet, J. 1826. Pianta, sezione, alzato del Tempio di Iside. In *Pompei e gli architetti francesi dell'Ottocento*. Ecole Française de Rome 1981. Digital copy for non commercial purposes.



25. Callet, F. E. Veduta del Tempio di Iside. In Pompei e gli architetti francesi dell'Ottocento. Ecole Française de Rome 1981..Digital copy for non commercial purposes.



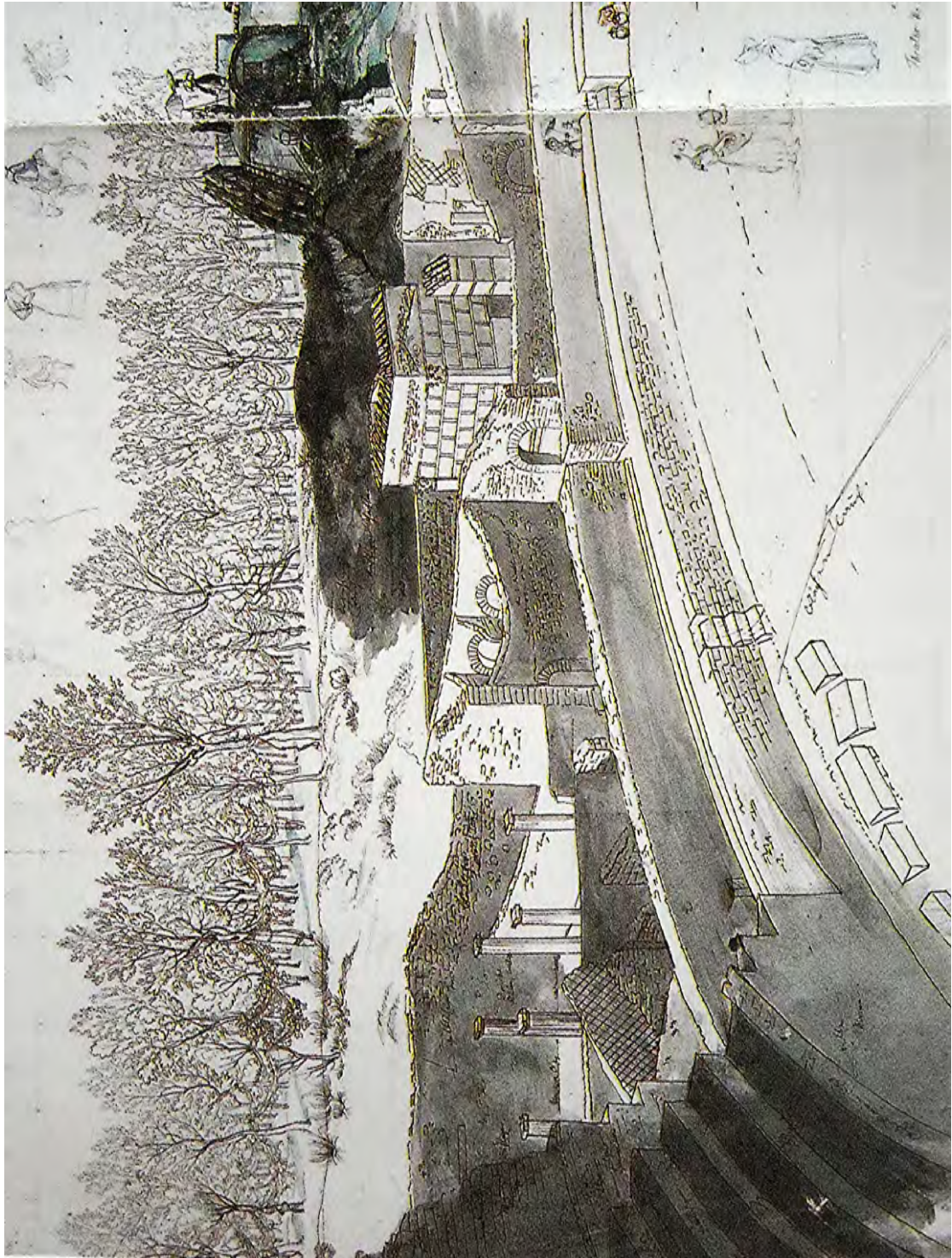
26. Durban, F. 1823-28. Due sezioni del Tempio di Iside. In Pompei e gli architetti francesi dell'Ottocento. Ecole Française de Rome 1981. Digital copy for non commercial purposes.



27. Bazzani, L. (1918). Il tempio di Iside a Pompeii. Watercolour. Digital copy for non commercial purposes.



28. Fabris, P. (1776) Lo scavo del tempio di Iside. In Hamilton, W. *Campi Phlegreaei*, 1776, tav. XLI. Digitised by the University of St Andrews. Reproduced for non commercial purposes.



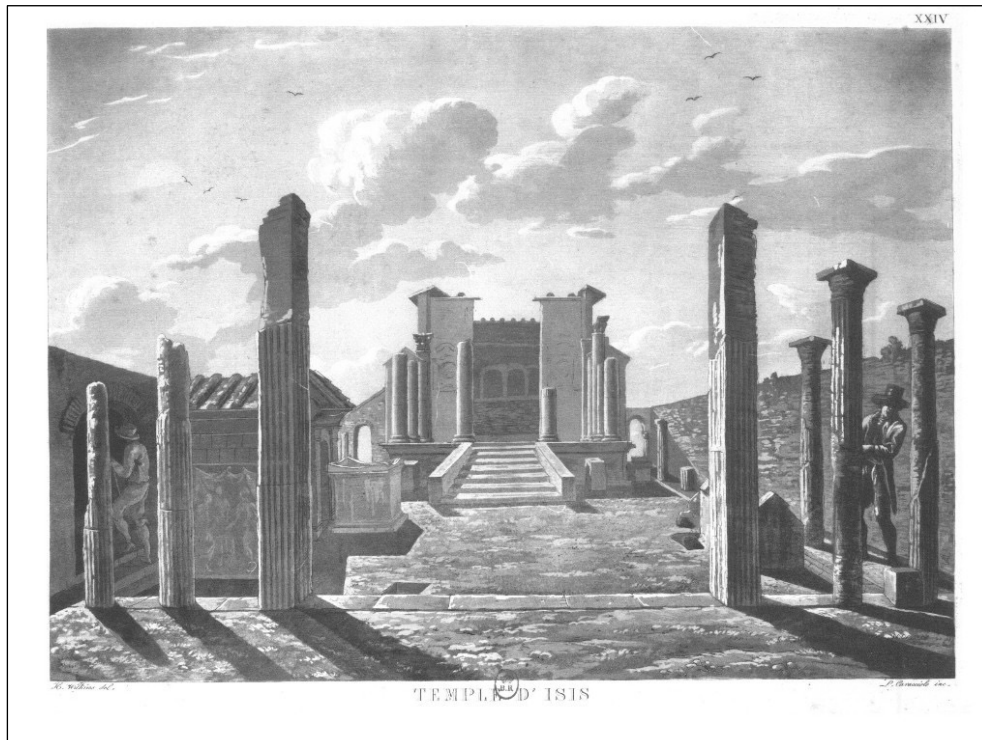
29. Enslen, C.G. (1826) Theatre and Temple of Isis at Pompeii. Source unknown. Reproduced for non commercial purposes.



30. Cooke, G. (1819) Pompeii Excavation of the Quarter of the Theatres etc. Published in Gell, W. (1821) Pompeiana : the topography, edifices, and ornaments of Pompeii. Rodwell & Martin, New Bond Street. Digital copy for non commercial purposes.



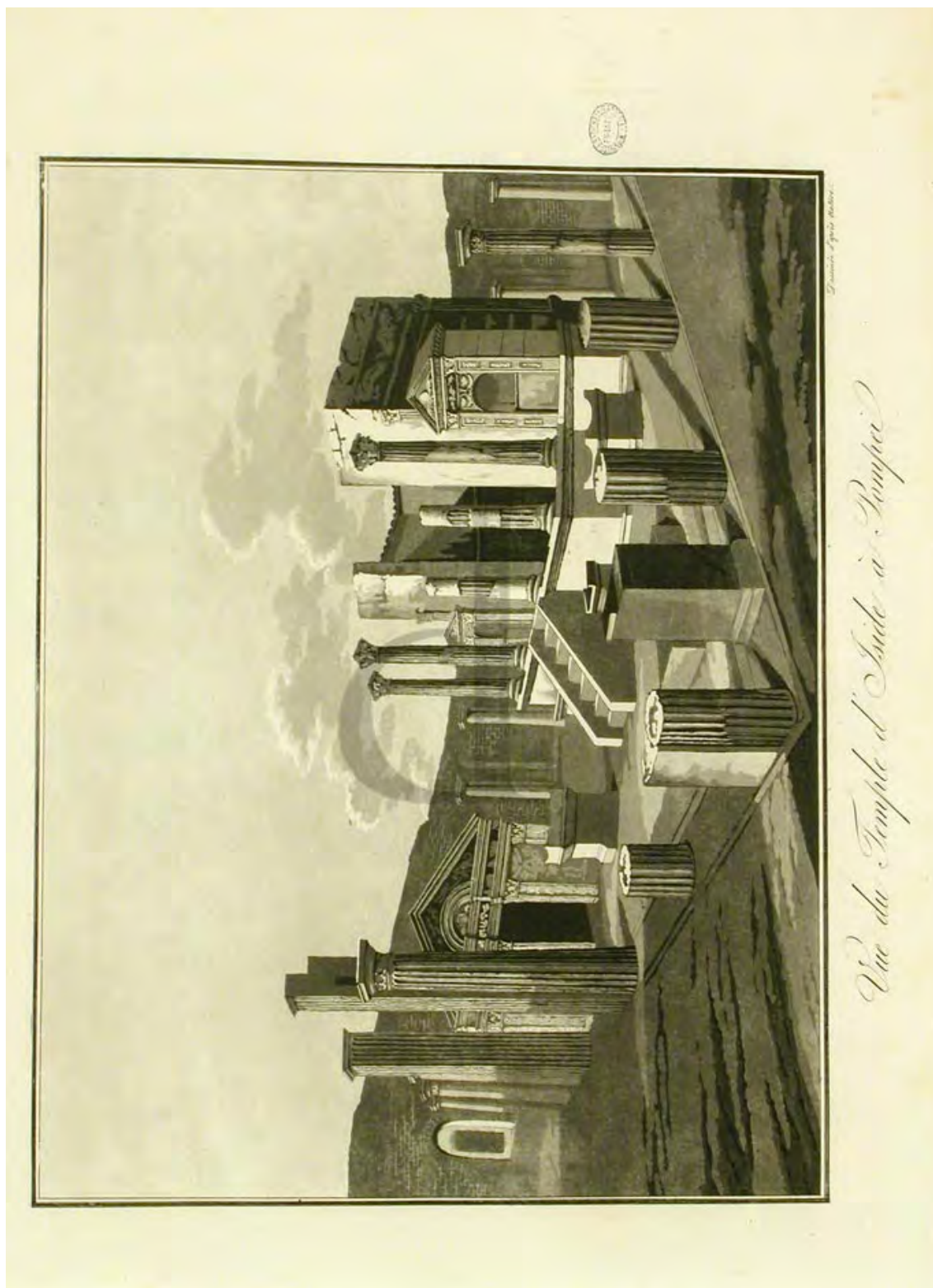
31. Woods, J (after Sharp, R.H.) Temple of Isis, Pompeii. XIX century. RIBA collection. Courtesy of RIBA. Reproduced for non commercial purposes.



32. Wilkins, H. (illustrator) & Caracciolo, L. (etcher) Temple d'Isis. In Wilkins H., Suite de vues pittoresques des ruines de Pompeii et un precis historique de la ville avec un plan des fouilles qui ont été faites jusqu'en Février 1819 et une description des objets les plus intéressants, Roma, 1819, Tav. XXIV. Public Domain. Source: Gallica



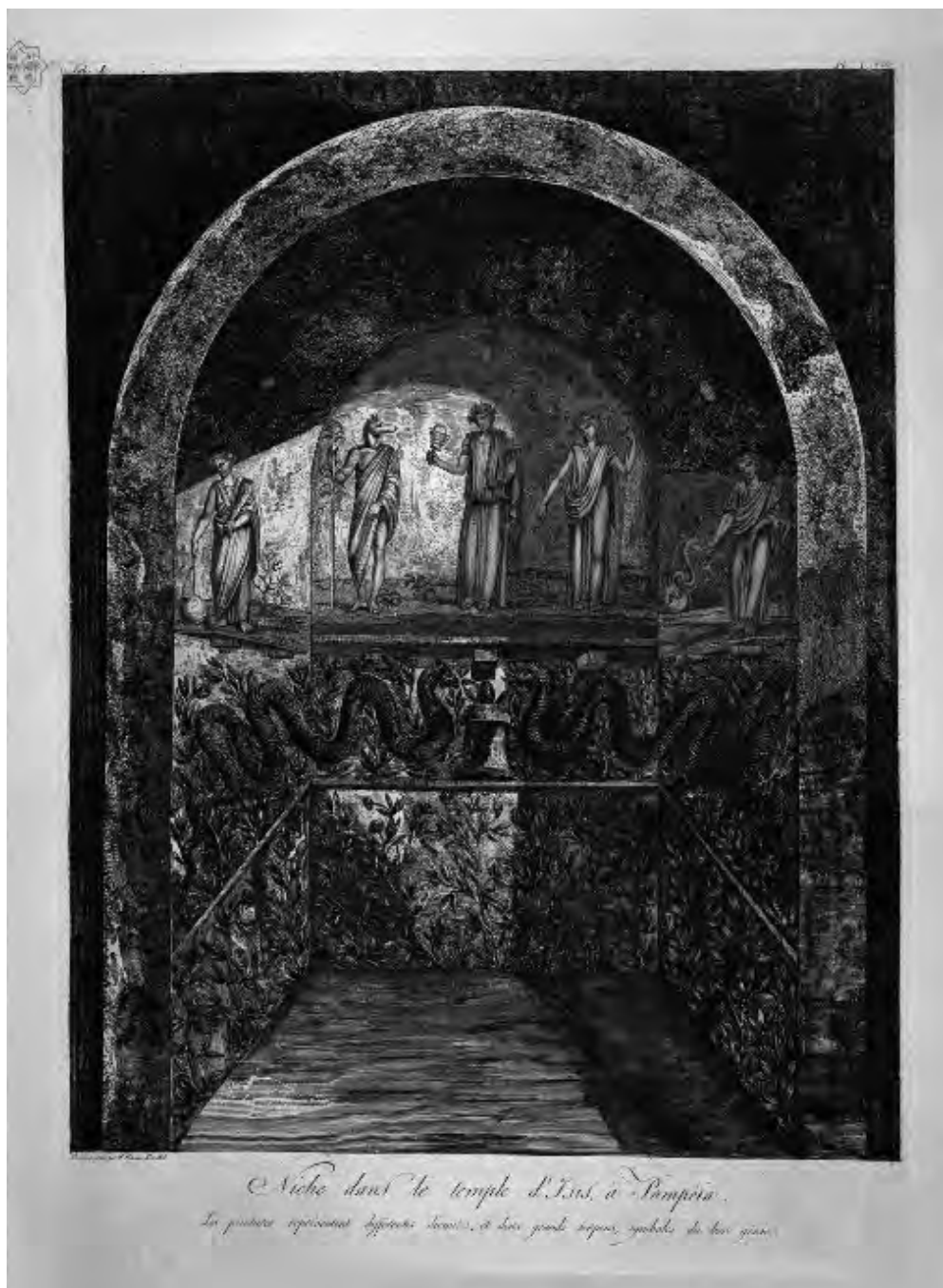
33. Wilkins, H. Pencil and watercolour drawing of the Temple of Isis. In Originalaquarelle zu: Wilkins, Suite de vues pittoresques des ruines de Pompeii et un precis historique de la ville..., Tav. XXIV. Reproduced for non commercial purpose. Source: La fortuna visiva di Pompei.



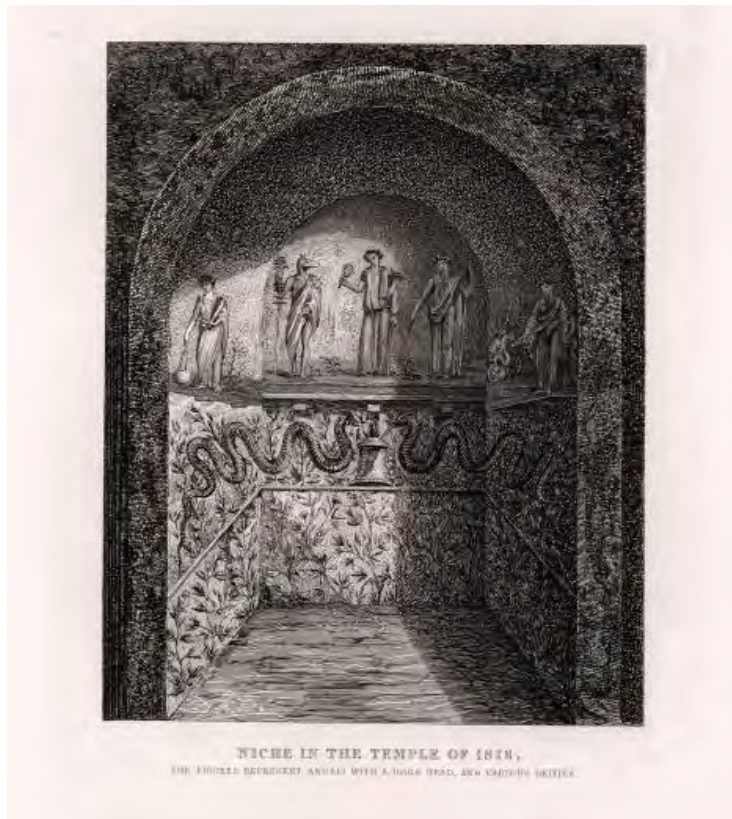
34. Anonymous. Vue du Temple d'Iside à Pompei (Dessiné d'après nature) In: Voyage pittoresque, historique, et géographique de Rome à Naples et leurs environs, Napoli, 1823 - 1824, P. 56. Reproduced for non commercial purpose. Source: La fortuna visiva di Pompei.



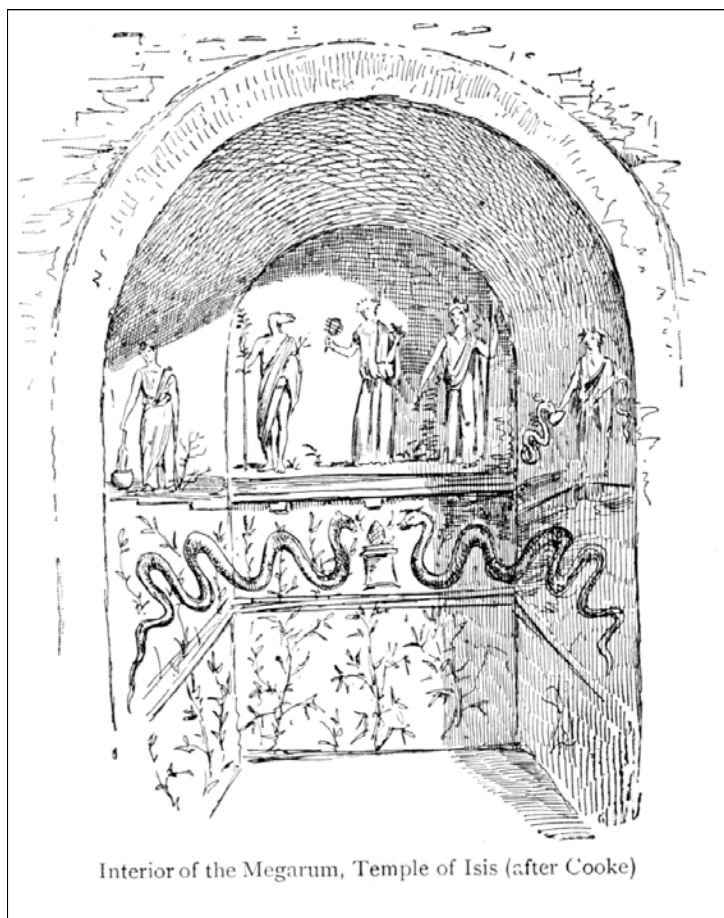
36. Piranesi, G.B. (1772-8) The Temple of Isis in Pompeii seen from the rear Pen and brown ink, over black chalk. British Museum Collection. Digitisation by British Museum. Reproduced for non commercial purposes.



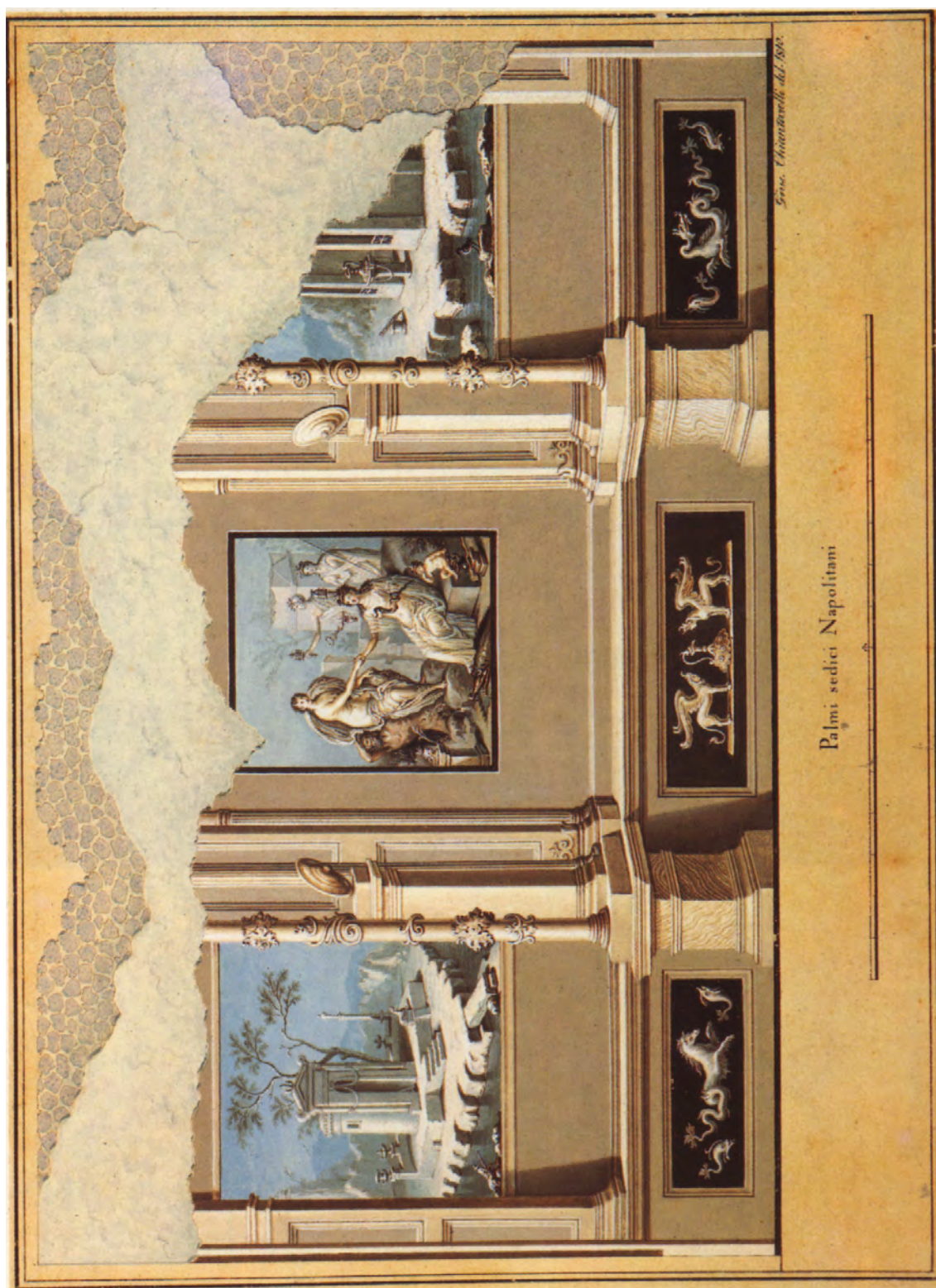
37. Piranesi, F. (illustrator and etcher). Niche dans le temple d'Isis, à Pompeia. In: Piranesi F., *Antiquités de la Grande Grèce aujourd'hui Royaume de Naples...*, Piranesi frères, 1804 - 1807, vol. III, Tav. I



38. Cockburn (Illustrator) & Cooke, W.B. (Etcher). Niche in the Temple of Isis (1827). In: Cooke, W. B., Pompeii, illustrated with picturesque views, engraved by W. B. Cooke, from the original drawings of lieut. col. Cockburn ... and with plans and details of the public and domestic edifices, including the recent excavations, and a descriptive letterpress to each plate, by T. L. Donaldson, architect ... in two volumes. Vol. I. London, 1827. Public domain. Source: Arachne



39. Gusman, P. Interior of the Megarum, Temple of Isis. (1900) In: Gusman, P., Pompei, the city, its life & art. London 1900. Public domain. Source: archive.org



40. Chiantarelli, G. South wall of the ekklesiasterion in the Temple of Isis in Pompeii. Published in Carratelli Pugliese, G. & Baldassarre, I. 2003. Pompei pitture e mosaici. Roma : Istituto della enciclopedia italiana. Digital copy for non commercial purposes.



41. Niccolini F, (1854). In *Le case ed i monumenti di Pompei: Volume Primo*. Napoli. (Tav. VIII). Public domain. Source: Arachne



42. Esposito, View of the Temple of Isis. Circa 1890. Source: Pompeiinpictures



43. Sommer, G. Tempio d'Iside Circa 1870. Source: Pompeiinpictures



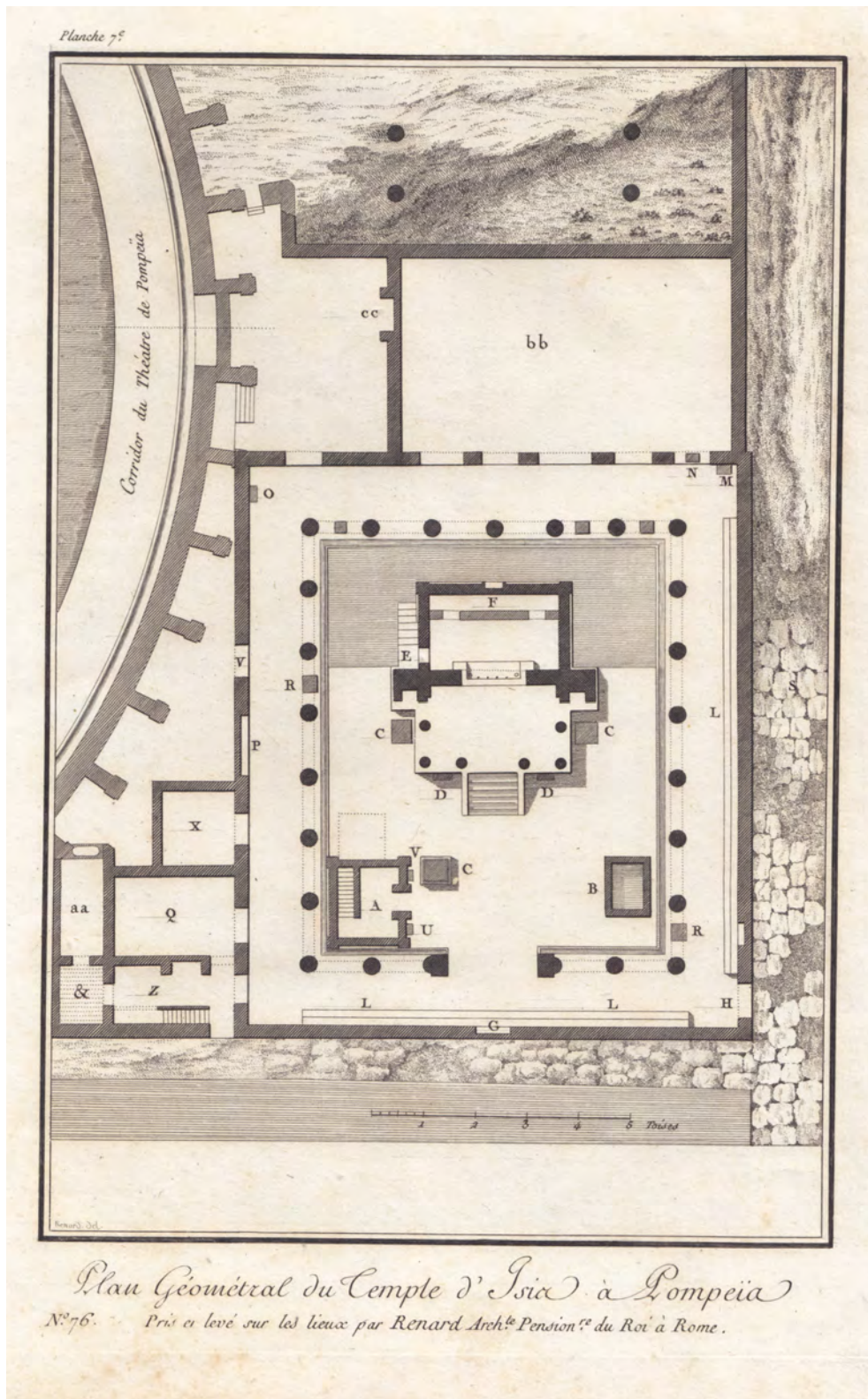
44. Fragment 1.66. Museum of Naples. Temple of Isis Collection. Ekklesiasterion. Sacred fence with temples, statues, and square with trees, seen through an architectural scene. Left area of the west wall. Photograph of the author (2012)



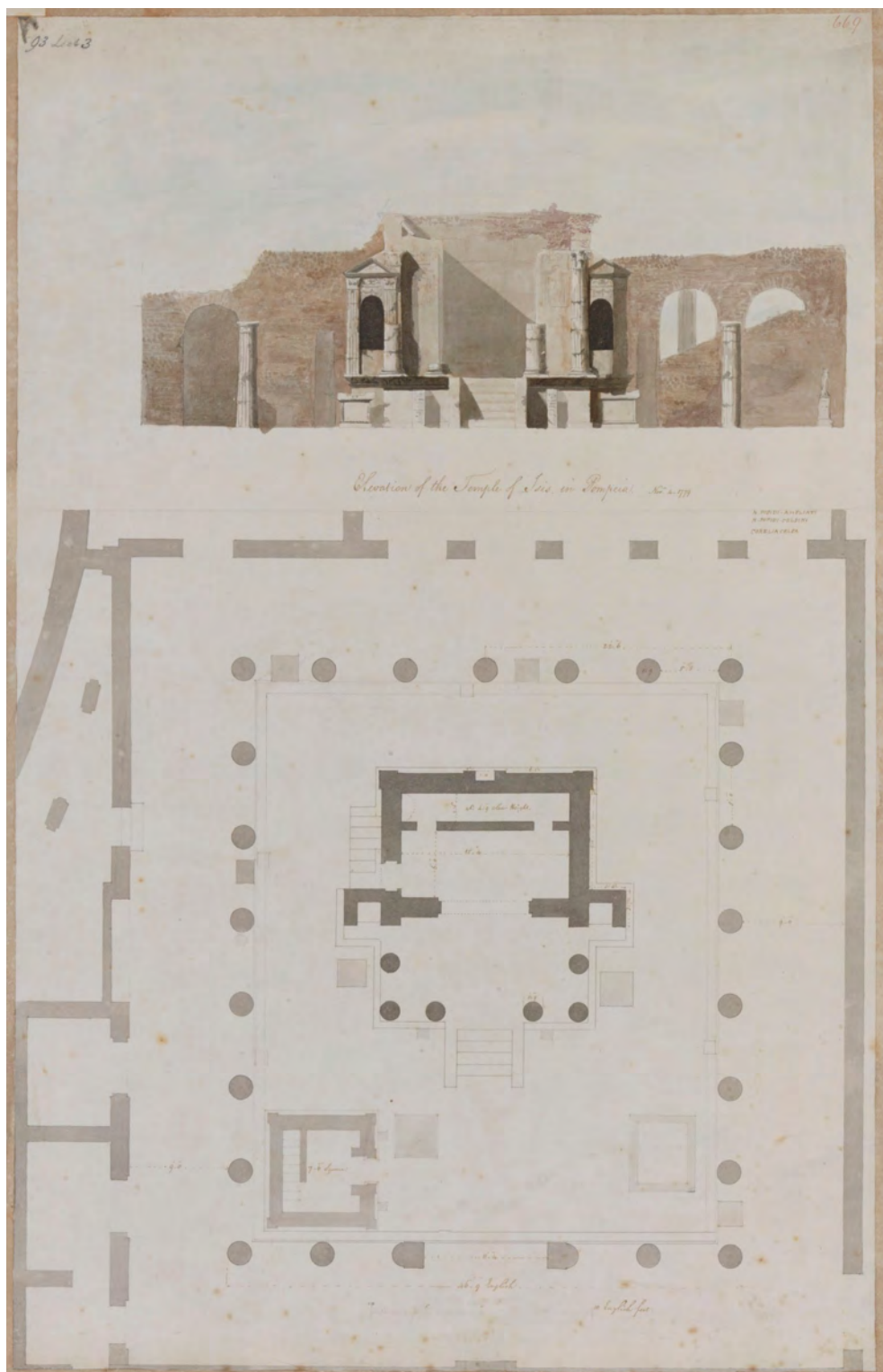
45. Fragment 1.67. Museum of Naples. Temple of Isis Collection. Ekklesiasterion. Landscape with sacred door and velum. Right area of the west wall. Photograph of the author (2012)



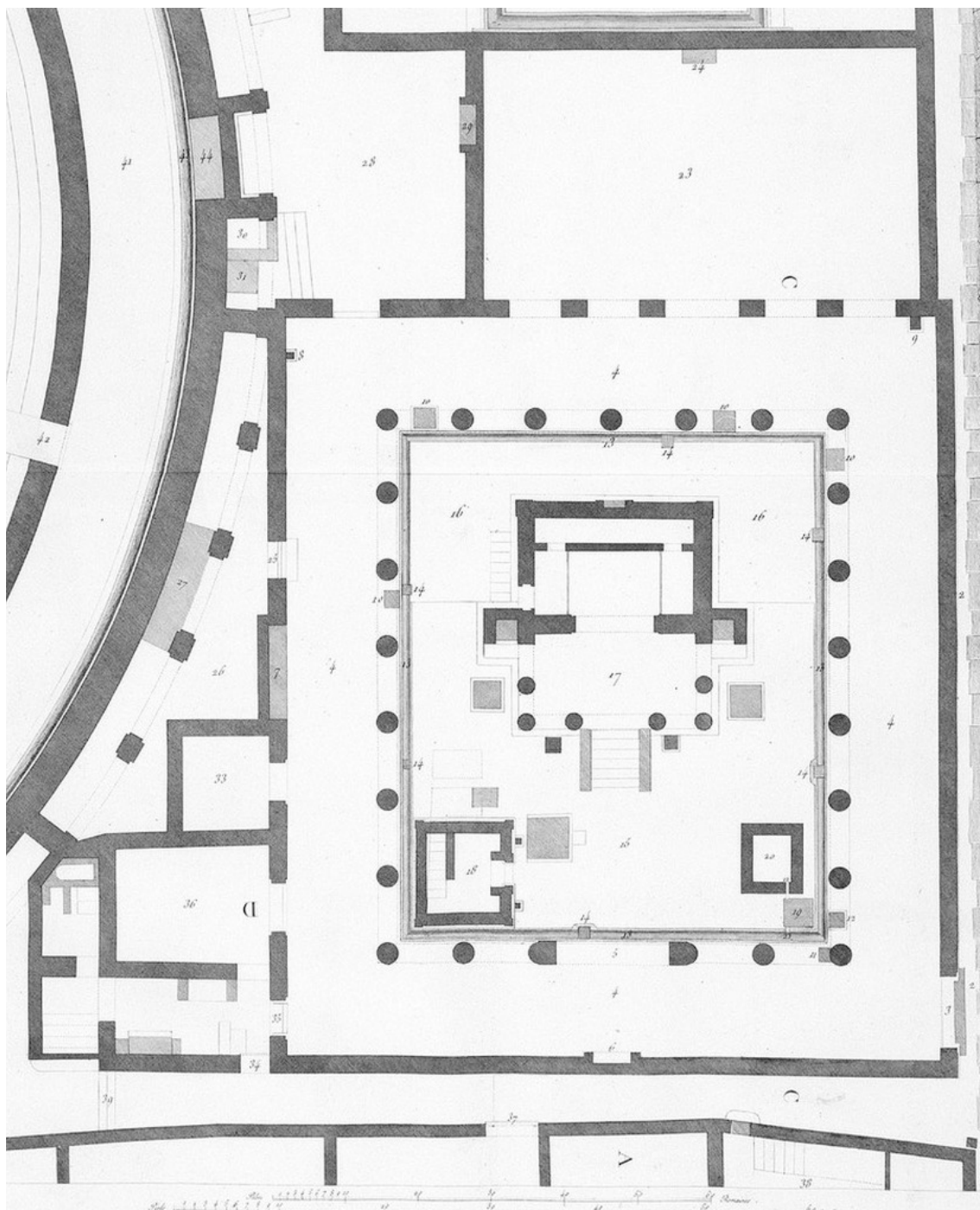
46. Fragment 1.62. Museum of Naples. Temple of Isis Collection. Ekklesiasterion. Landscape with ceremony in honour of Osiris. Left area of the south wall. Photograph of the author (2012)



47. Jean Claude Richard's plan for the Temple of Isis in Pompeii. *Voyage Pittoresque ou Description des Royaumes De Naples Et De Sicile*, 1782. Digital copy for non commercial purpose



48. John Soane's plan and front elevation for the Temple of Isis in Pompeii. Courtesy of the Soane Museum in London. Reproduced for non commercial purposes.



49. Piranesi's plan for the Temple of Isis in Pompeii. *Table du second Volume des antiquités de Pompeia*. Digital copy for non commercial purpose

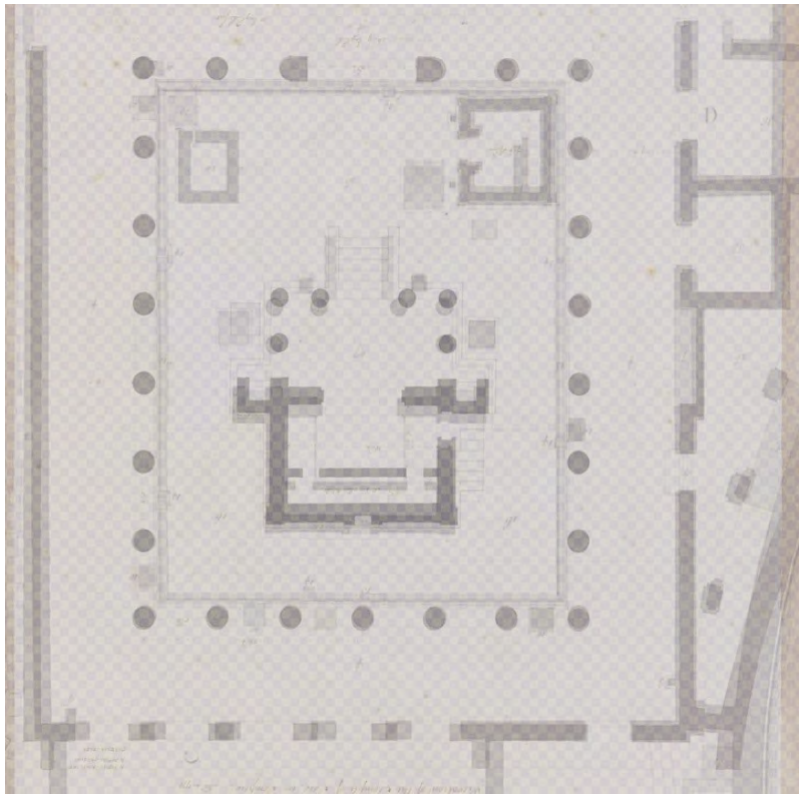


50. Scale model of the Iseum exhibited in the Museo Archeologico Nazionale di Napoli. Photograph by the author (2012)

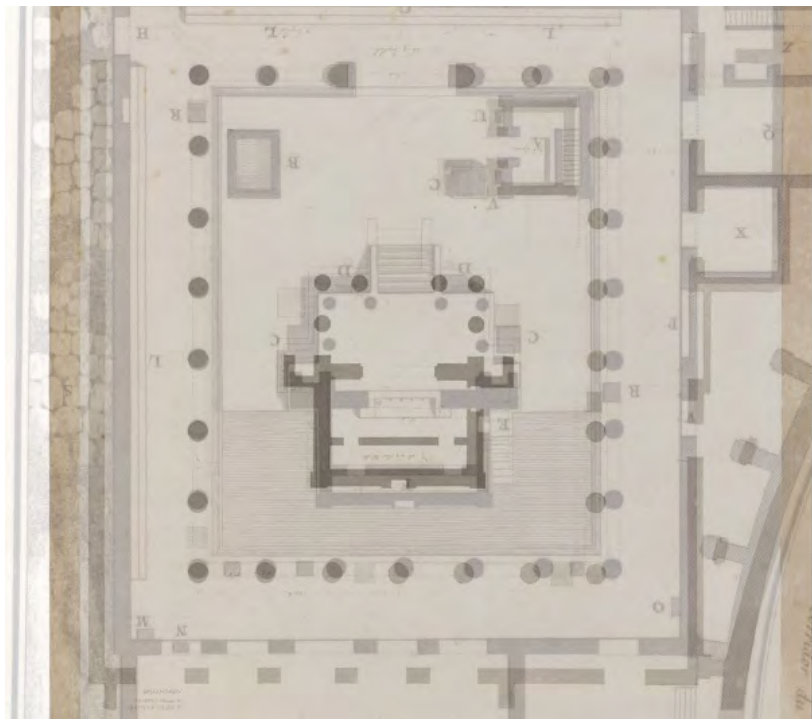


51. Marble threshold of the Temple of Isis. Photograph by the author (2014)

Other images



52. Digital comparison (at reduced opacity) between the plans of the Iseum by Piranesi and Soane.



53. Digital comparison (at reduced opacity) between the plans of the Iseum by Saint-Non and Soane.



54. Detail of the fresco in the garden of the House of Orpheus in Pompeii. Photograph by the author (2014)



55. Niccolini, F. (1854) *Le Case ed i Monumenti di Pompei: disegnati e descritti*. Napoli. Public domain. Source: Arachne



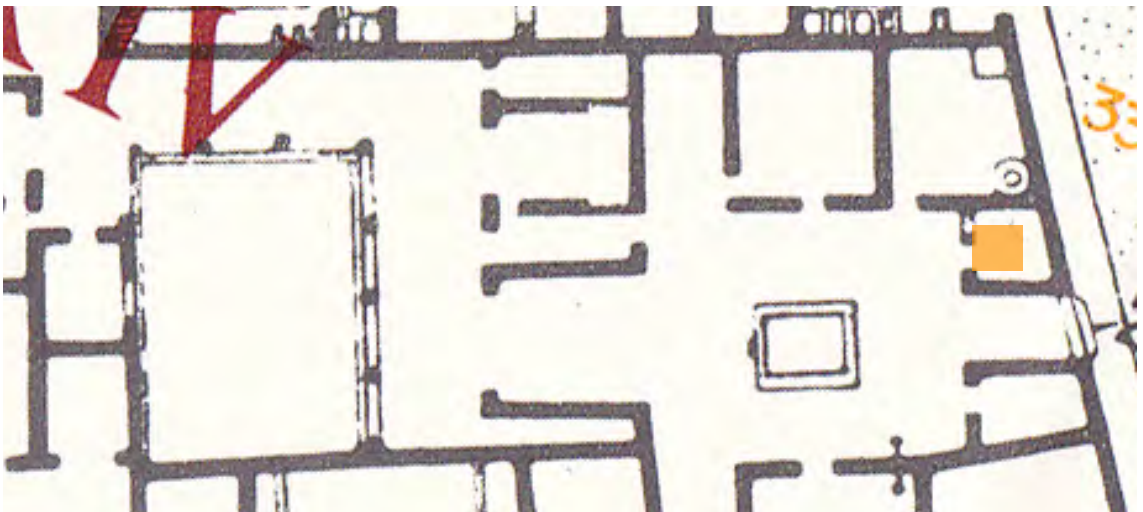
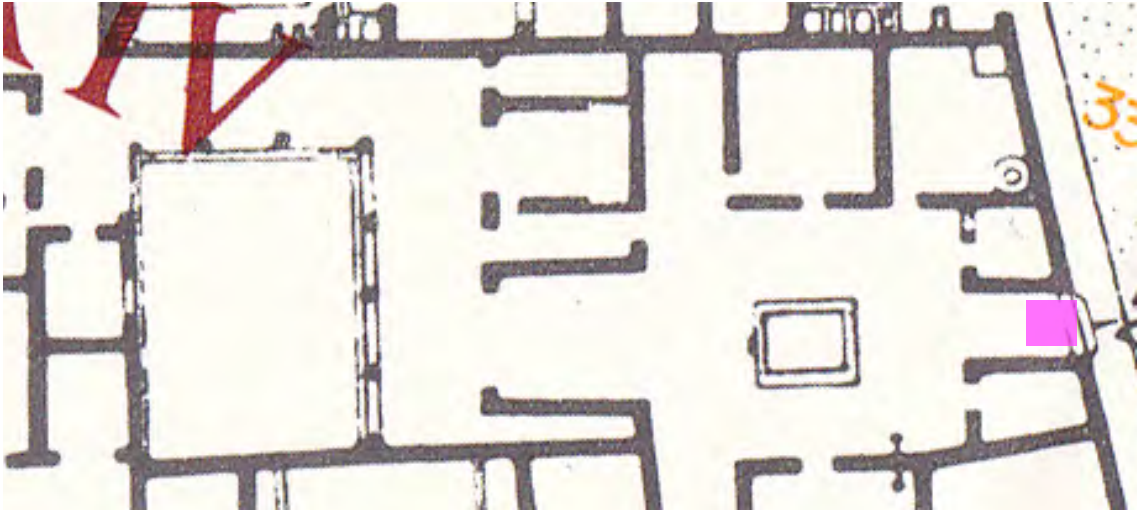
56. Presuhn, E. (1878) in *Les Décorations Murales de Pompéi*. Leipzig. Public domain. Source: Arachne.



57. Mosaic of a dog. Found in the House of Orpheus in Pompeii. Photograph by the author (2012)



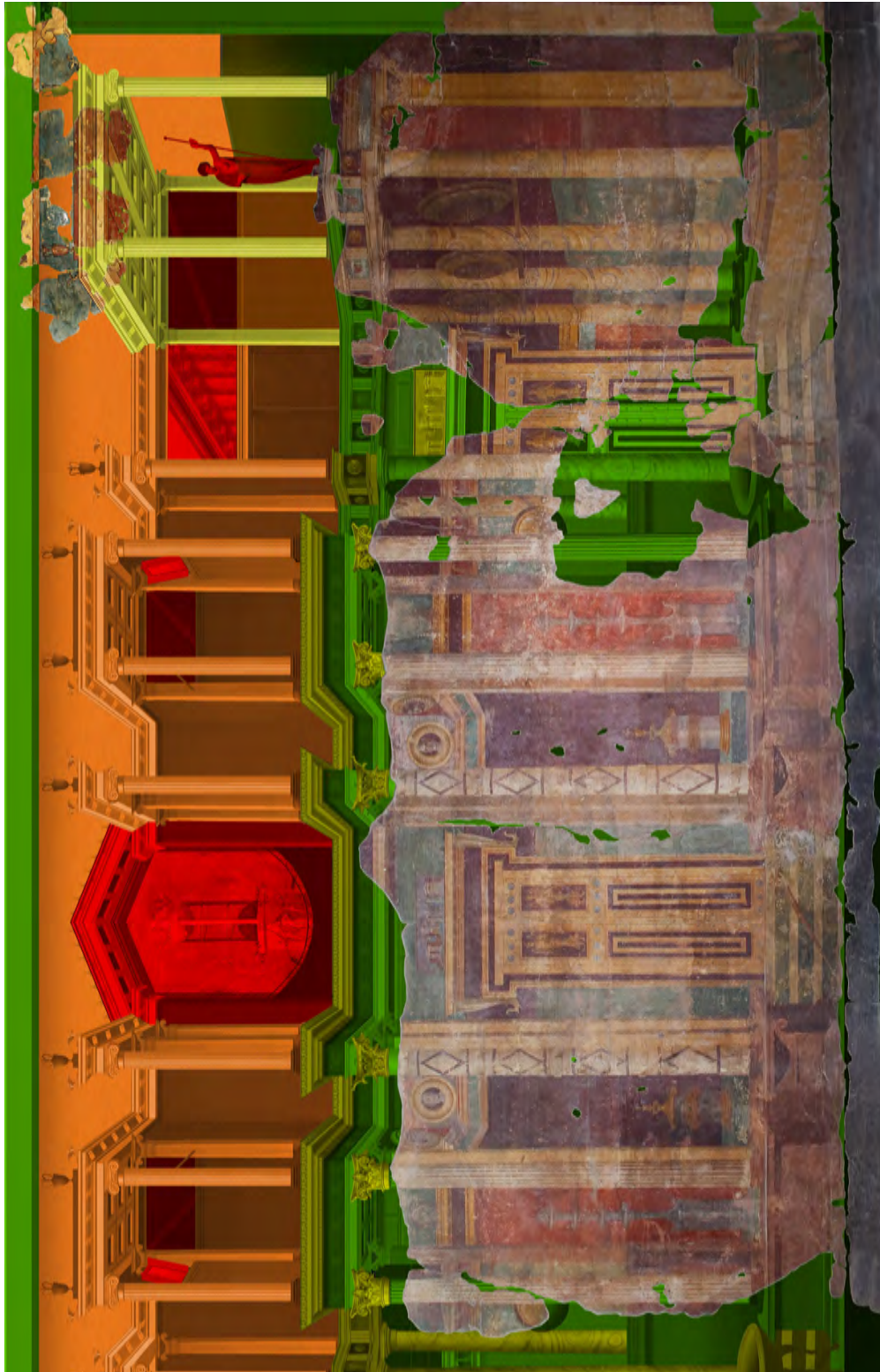
58. Plaster cast of a dog. Found in the House of Orpheus in Pompeii. Photograph taken in the British Museum during the exhibition *Life and Death in Pompeii and Herculaneum* (London 2013). Source: wikicommons



60. Expected placement of the mosaic of a dog in the context of the House of Orpheus (Top), compared to its actual placement, according to Della Corte's records (Bottom). Edited detail of the plan of Pompeii by Van der Pohl.



61. Funerary relief of Vivius Marcianus in the Ashmolean museum, and a selection of its copies. From left to right, top to down: Prideaux (1676), Gale (1709), Allen (1827), Knight (1841), Archer (1852). Source: Ashmolean Museum blog (<http://blogs.ashmolean.org/latininscriptions/2014/03>).



62. Balzeby, M. Hypothetical restoration of a fresco in the Villa of Oplontis showing different degrees of certainty. Reproduced with permission of the author.



63. Borra, D. 3D visualisation of the villa of the Emperor Trajan in the Aniene Valley.
Source: NoReal website. Reproduced with permission of the author



64. Ternite, W. (1858) Sitzende Muse. Wandgemälde aus Pompeji und Herculaneum nach den Zeichnungen und Nachbildungen in Farben : von W. Ternite ; mit einem erläuternden text von C. O. Müller. Berlin. Public domain. Source: Arachne.



65. Ternite, W. (1858) Quellorakel. Wandgemälde aus Pompeji und Herculaneum nach den Zeichnungen und Nachbildungen in Farben : von W. Ternite ; mit einem erläuternden text von C. O. Müller. Berlin. Public domain. Source: Arachne.



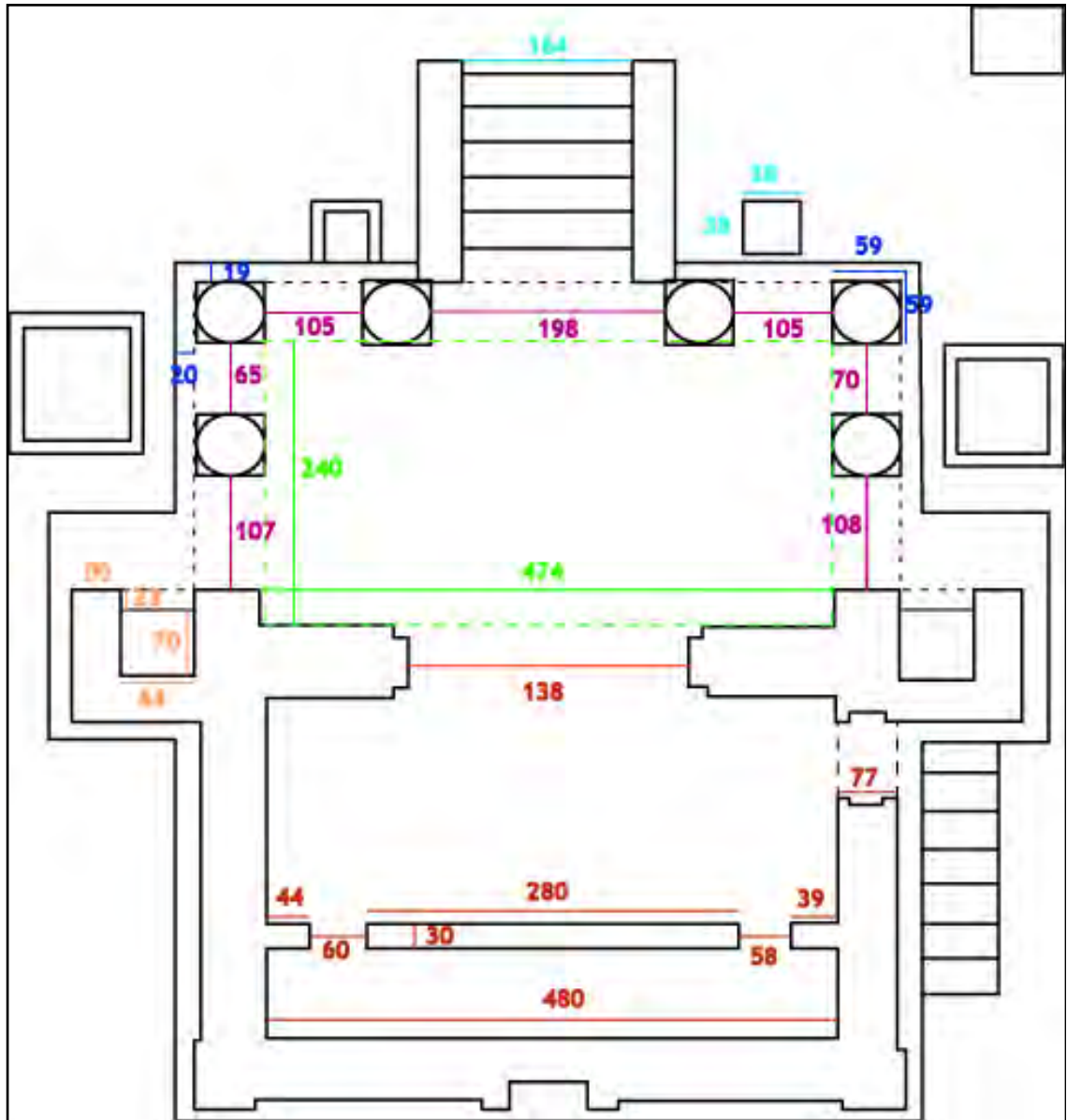
66. Hercules and Telephus. Detail of a fresco found in Herculaneum. Source: wikicommons



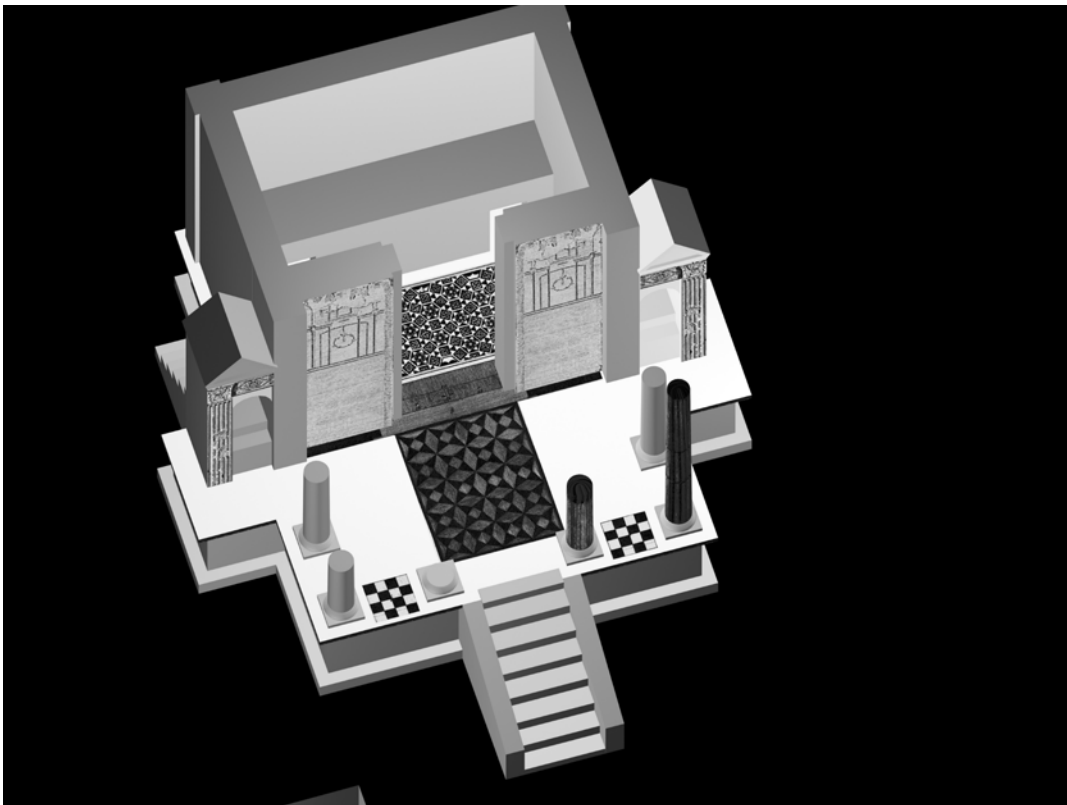
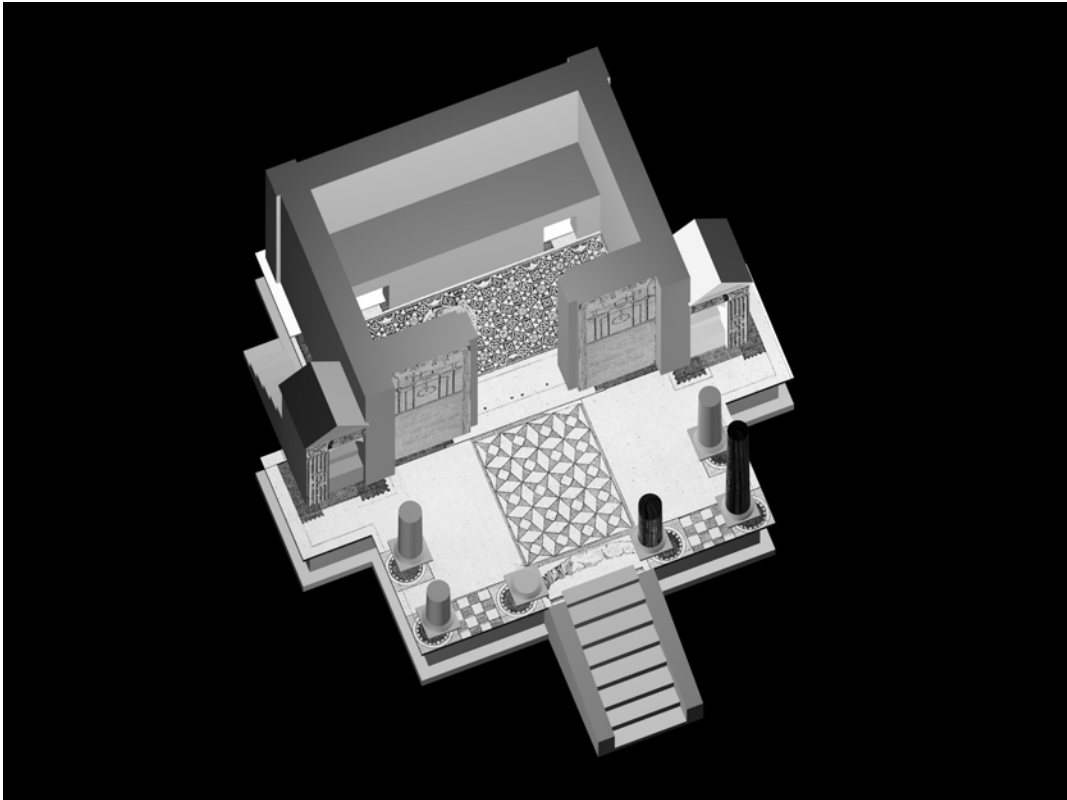
67. Montagny E-H. (1804 circa) Hercules and Telephus. Sketch from Montagny E-H. (1804-5) Recueil d'antiquités dessinée d'après des peintures trouvées à Herculaneum, Stabia et Pompeia qui sont maintenant au Musée de Portici à quatre milles de Naples. Getty Research Institute. Source: digital Montagny project.



68. Unknown artist after an etching by Charles-Nicolas Cochin the younger, draughtsman and engraver, 1715-1790. Hercules and Telephus. No. IV. of Curiosities found in the Ruins of HERCULANEUM. Public domain. Source: Library of Congress.

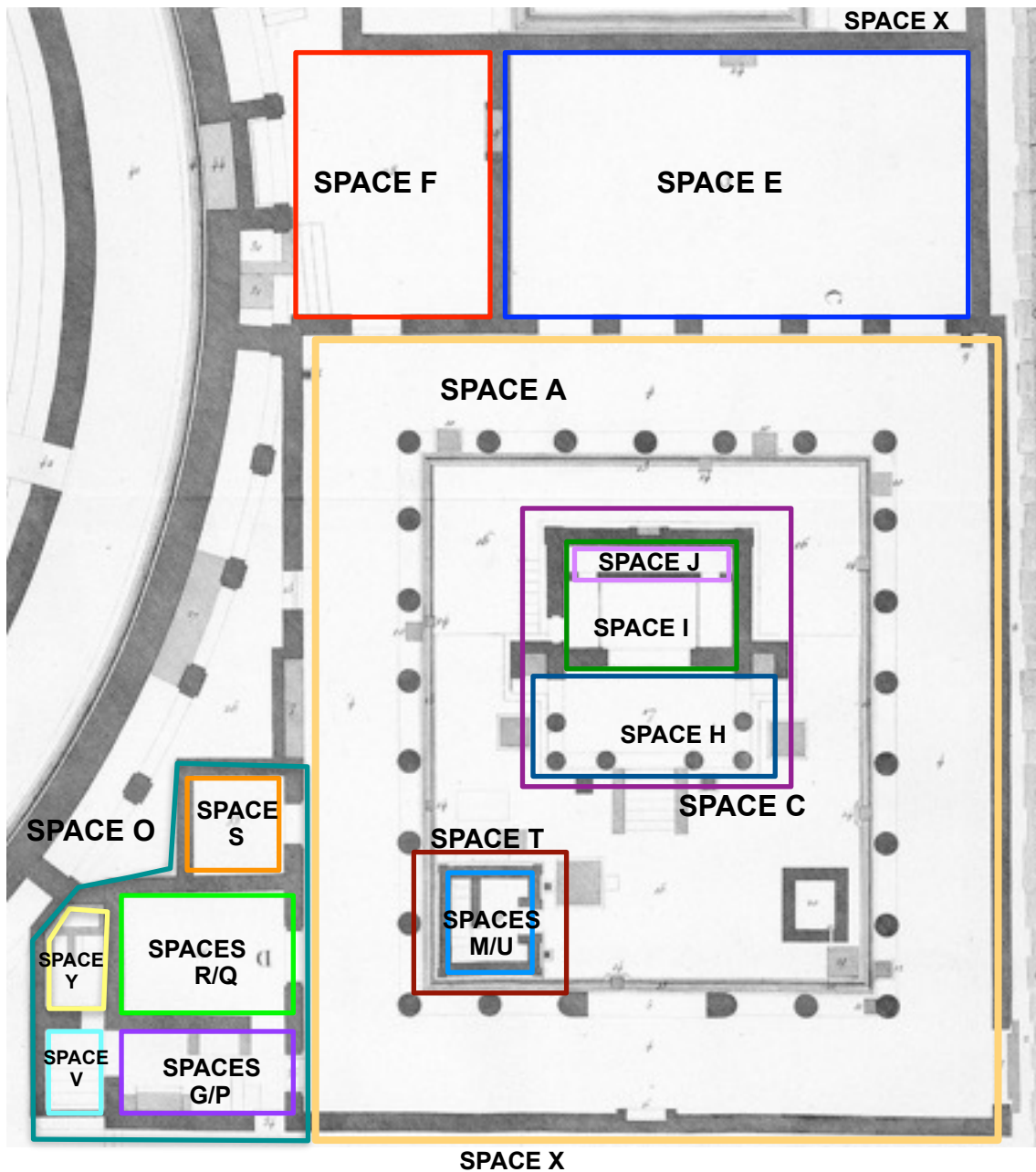


70. Edited measurements records, taken in Pompeii in 2014. Temple of Isis.



71., 72. The texture of the podium of the Temple of Isis before and after the editing.

Appendix H. Table of Spaces in the Iseum in Pompeii

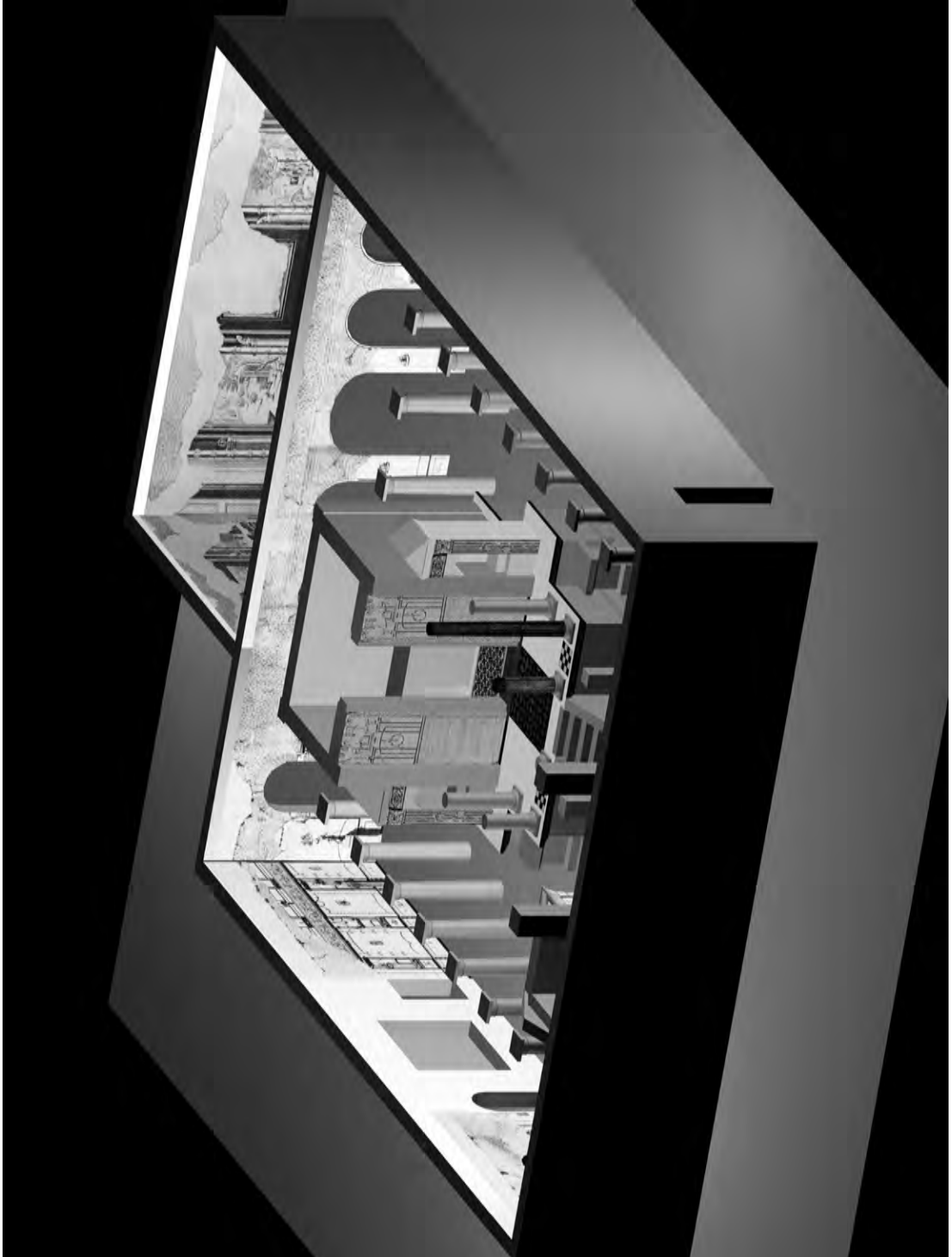


SPACE A: Portico
SPACE C: Temple of Isis
SPACE H: Pronaos of the Temple of Isis
SPACE I: Cella of the Temple of Isis
SPACE J: Cellar of the Temple of Isis
SPACE E: Ekklesiasterion
SPACE F: Sacrarium
SPACE O: Private Rooms
SPACE G: Kitchen
SPACE P: Second storey room above the kitchen

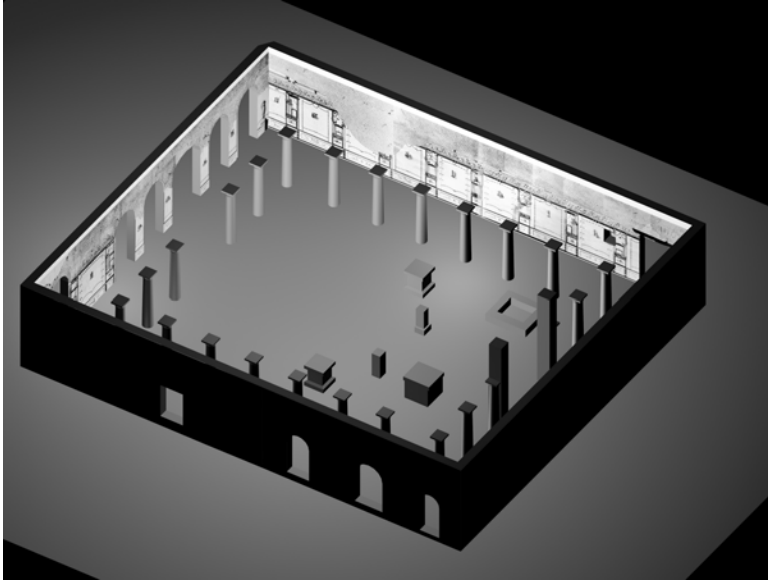
SPACE R: Triclinium
SPACE Q: Second storey room above the triclinium
SPACE S: Cubiculum
SPACE V: Unidentified space
SPACE Y: Unidentified space
SPACE T: Purgatorium
SPACE M: Ground floor of the purgatorium
SPACE U: Underground room of the purgatorium
SpaceX: Area outside the Iseum

Appendix I: Renderings of the 3D visualisations of the Pompeian Iseum

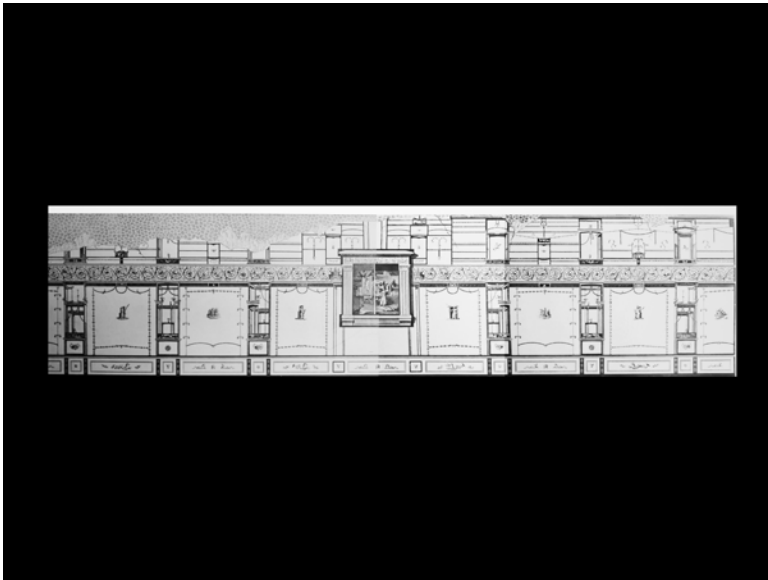
I.1. IseumGT



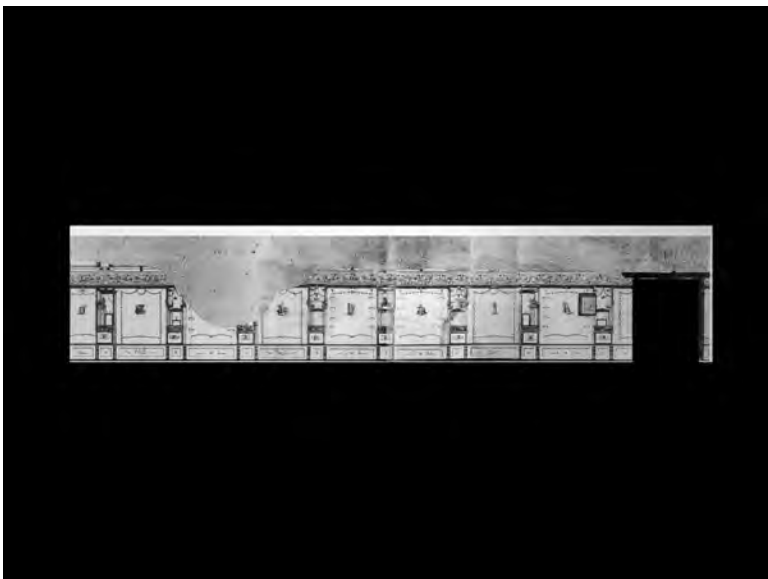
IseumGT



SpaceA_GT



SpA_CoE_GT



SpA_CoN_GT



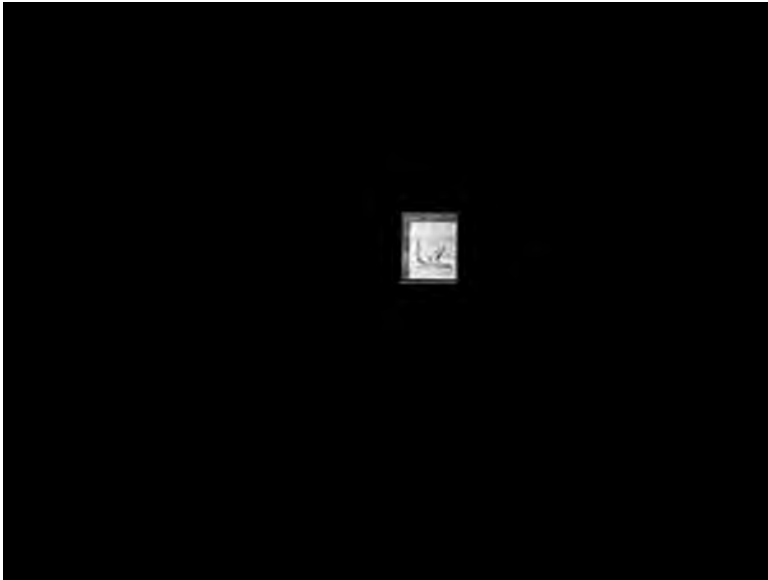
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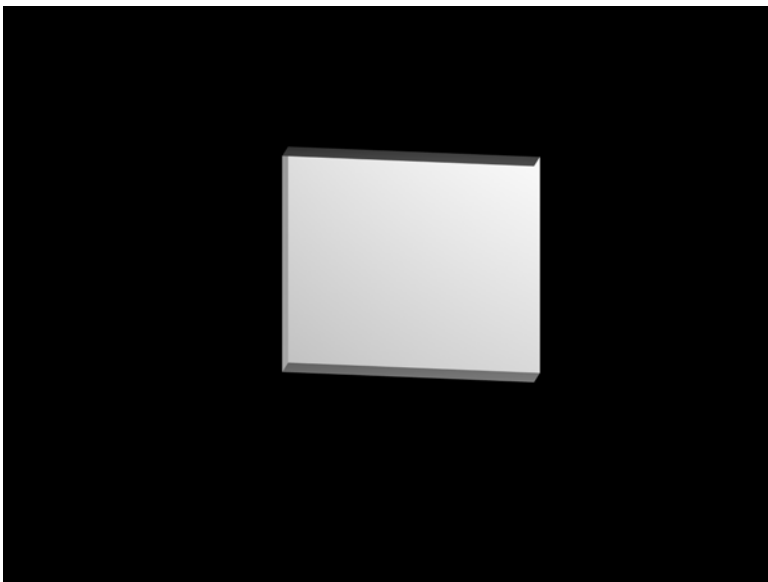
SpA_CoW_GT



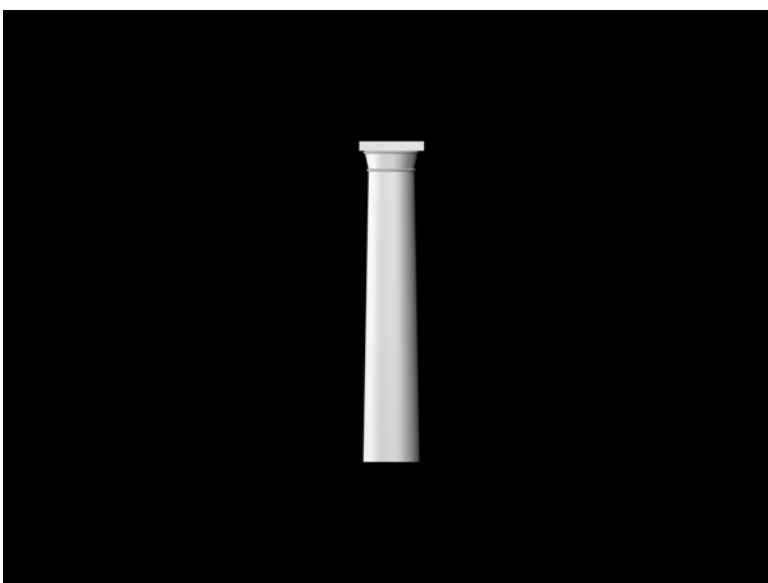
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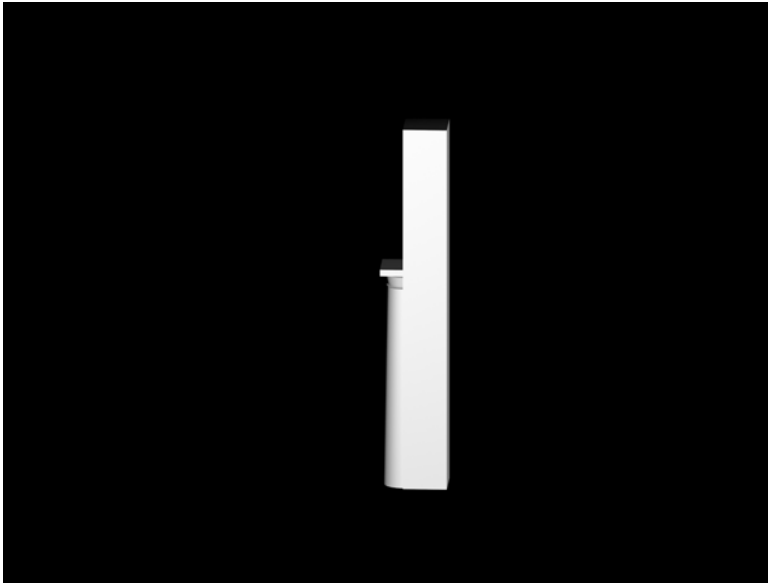
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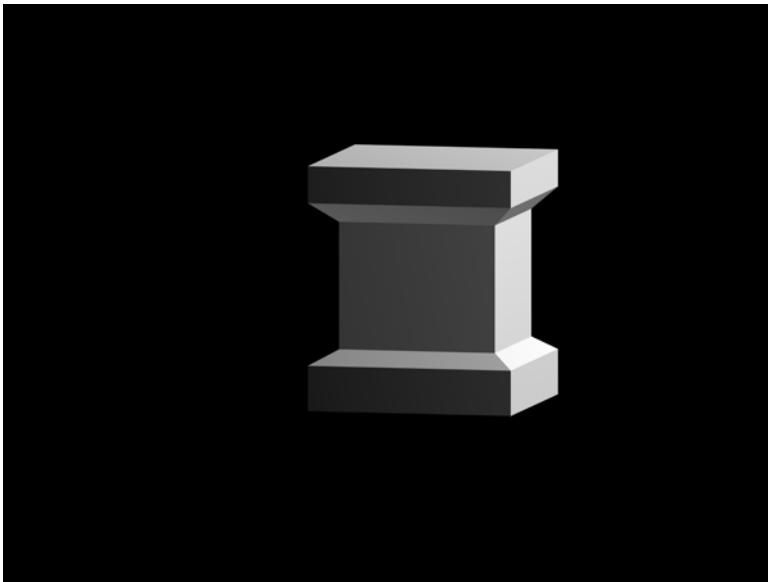
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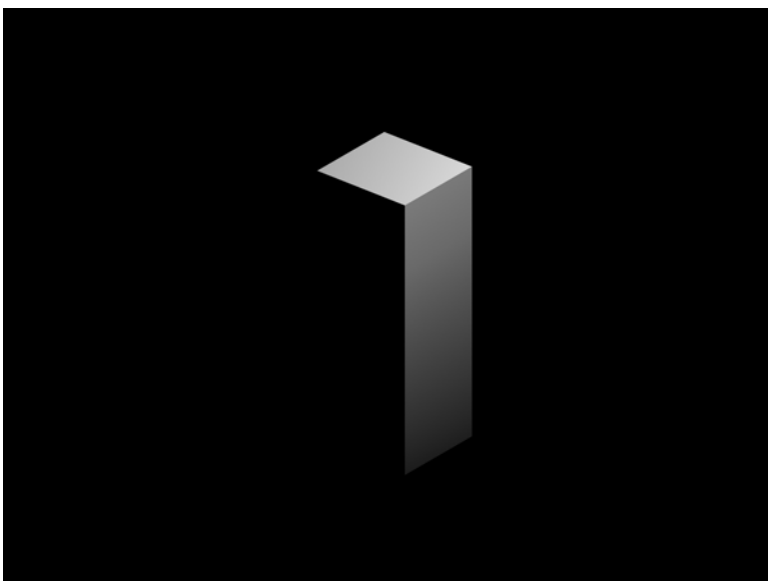
SpA_F01_GT/
SpA_F22_GT



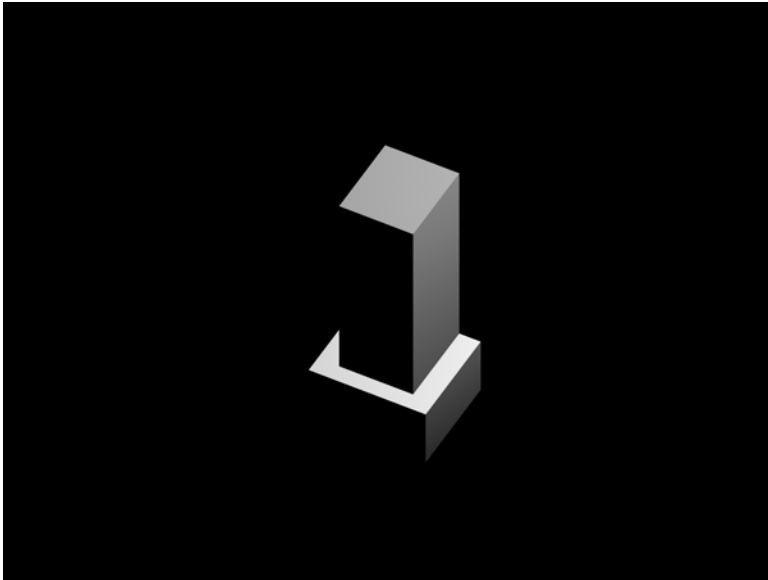
SpA_F23_GT/
SpA_F24_GT



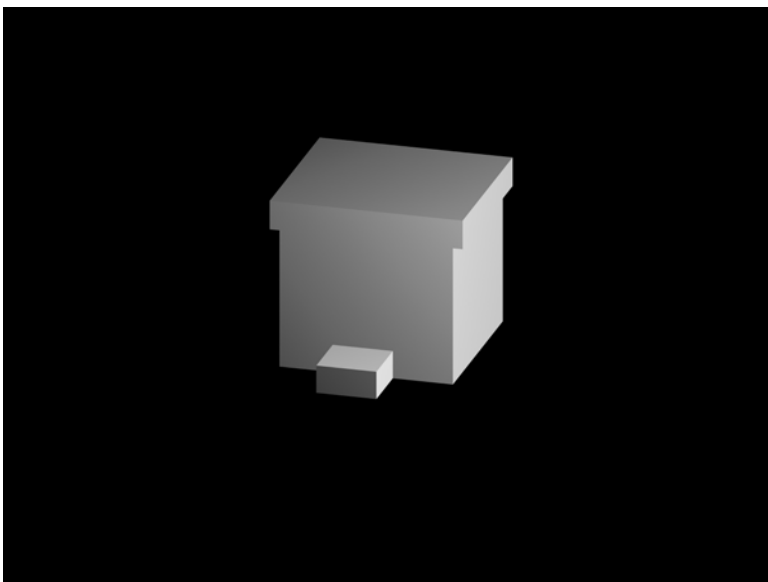
SpA_F25_GT/
SpA_F26_GT



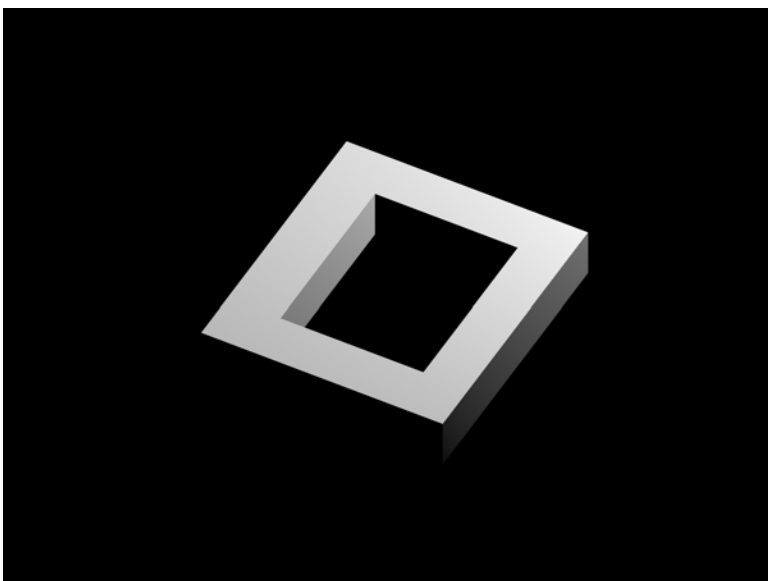
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SpA_F28_GT



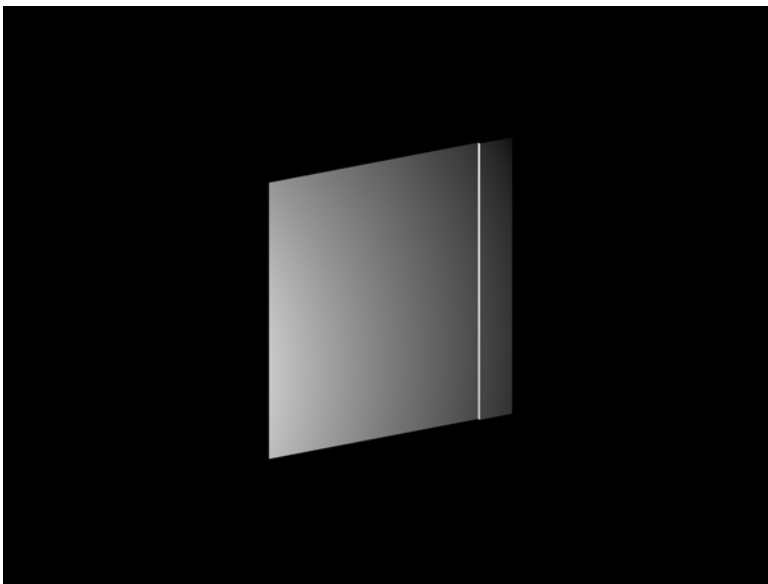
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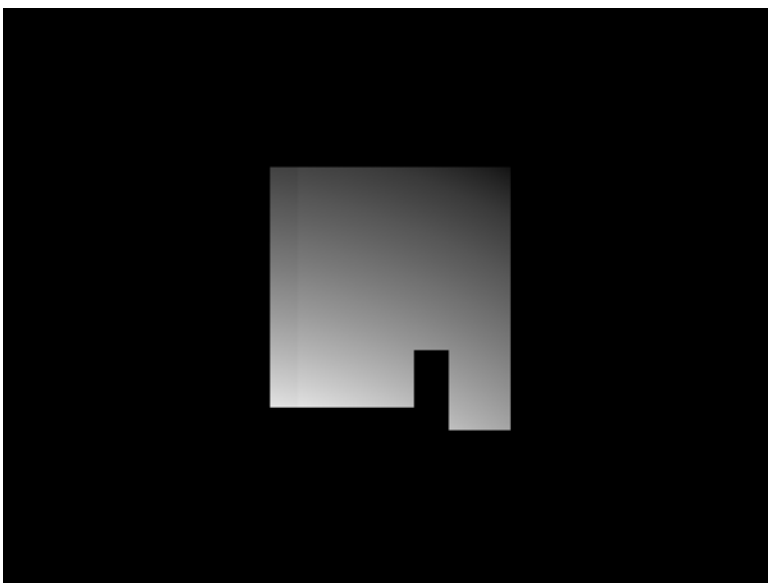
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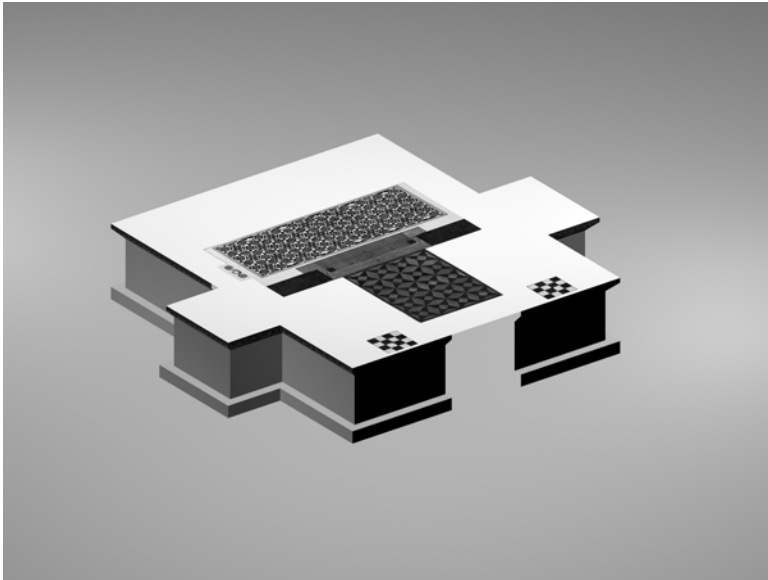
SpaceC_GT



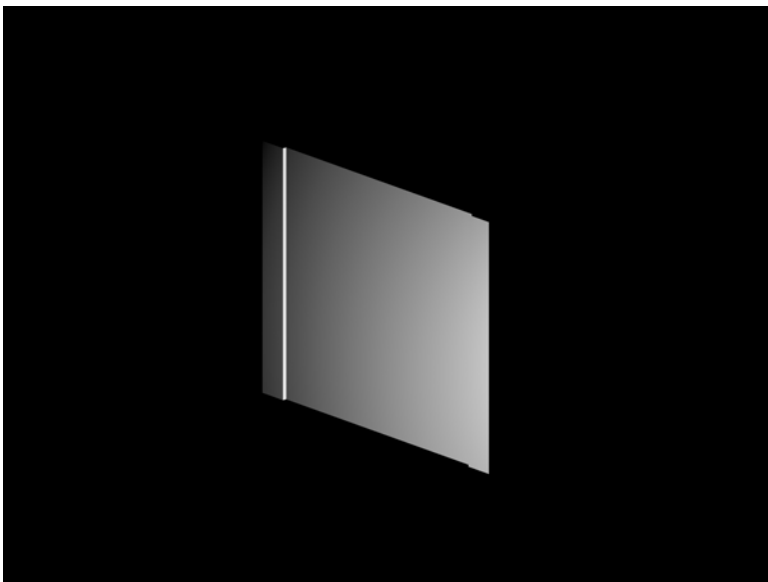
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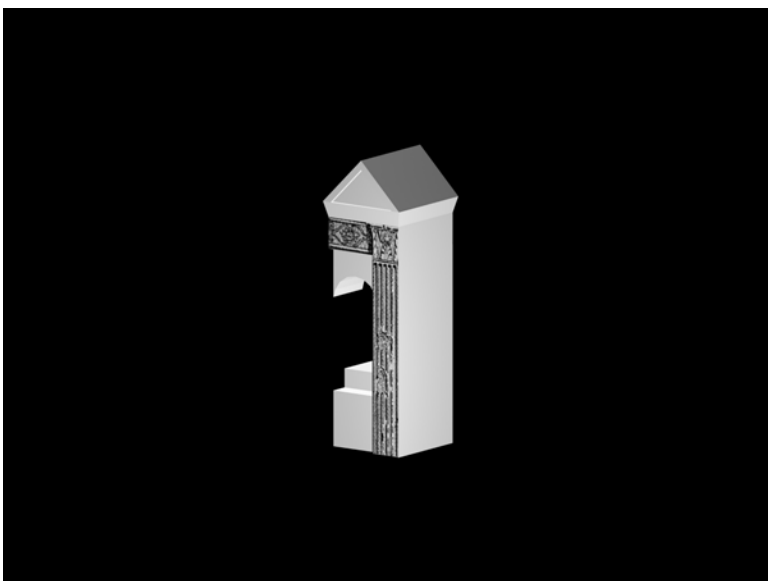
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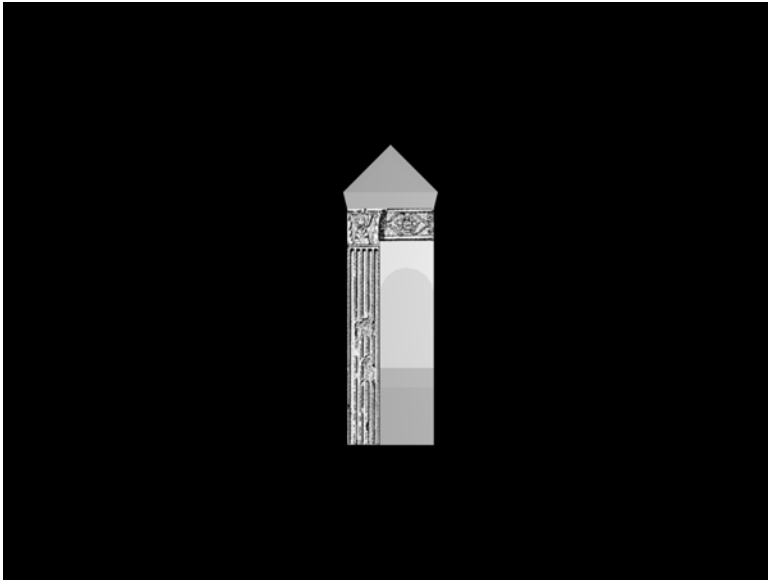
SpC_CoD_GT



SpC_CoW_GT



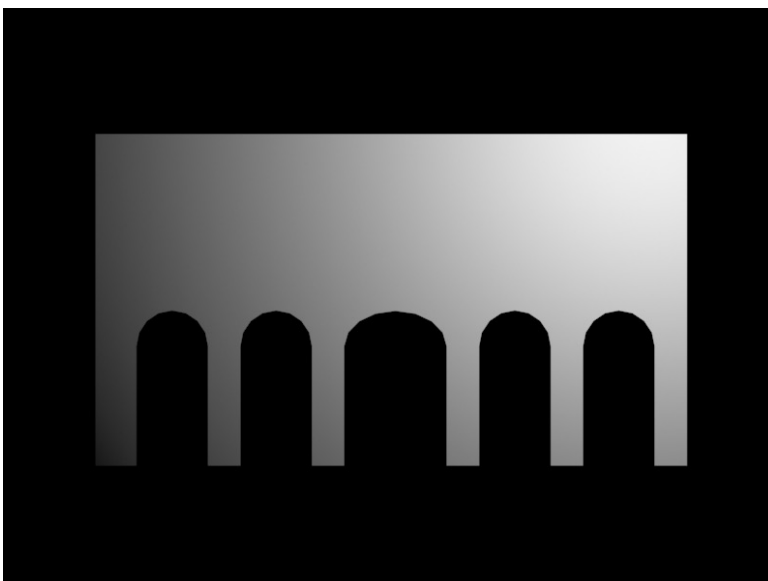
SpC_F01_GT



SpC_F02_GT



SpaceE_GT



SpE_CoE_GT



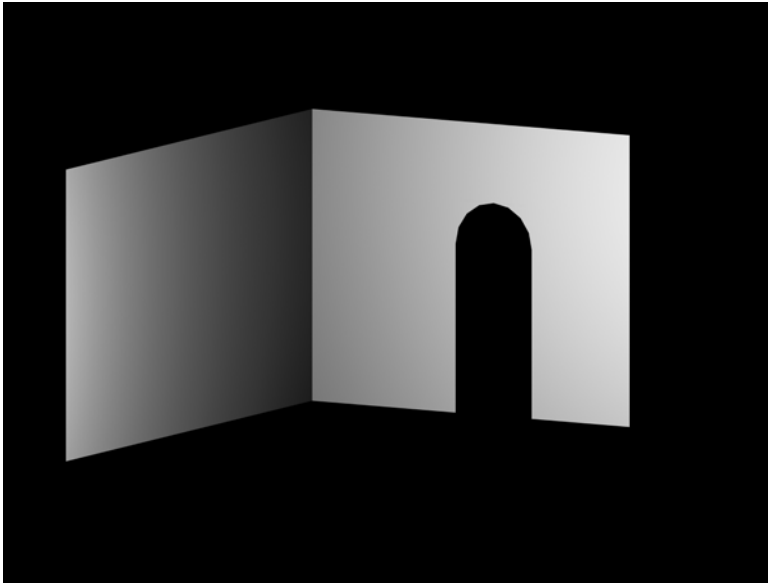
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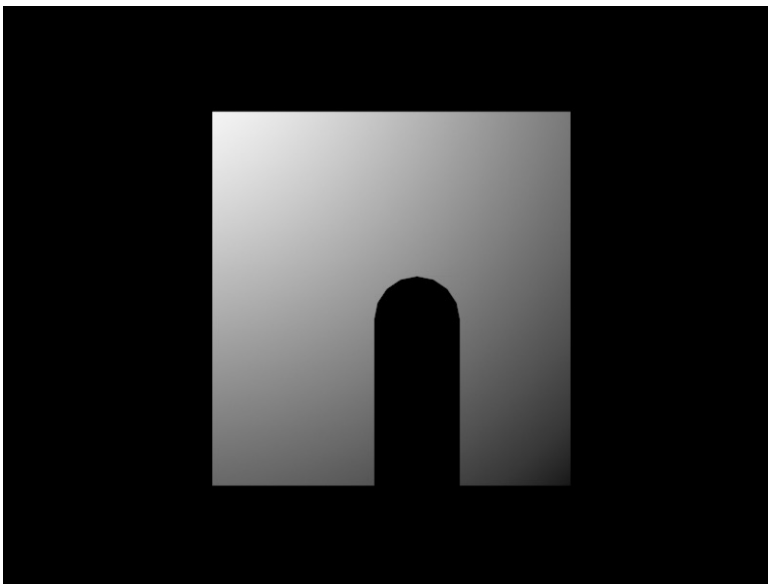
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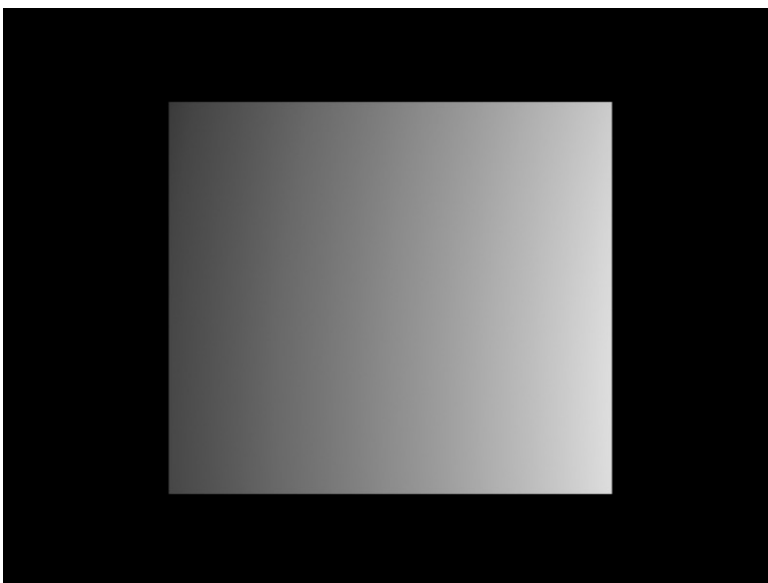
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SpaceF_GT



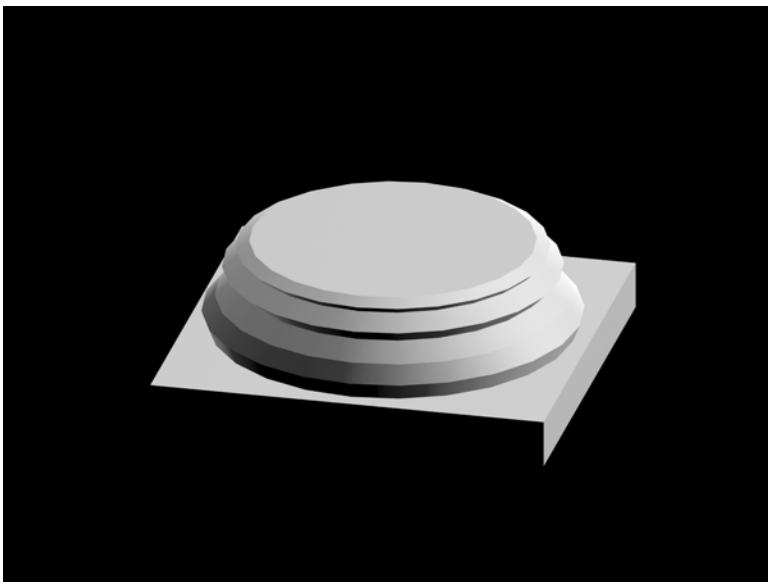
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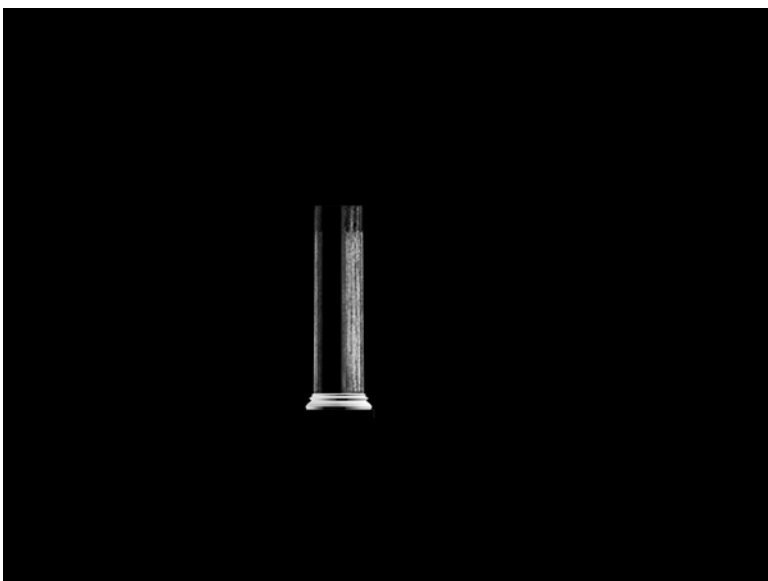
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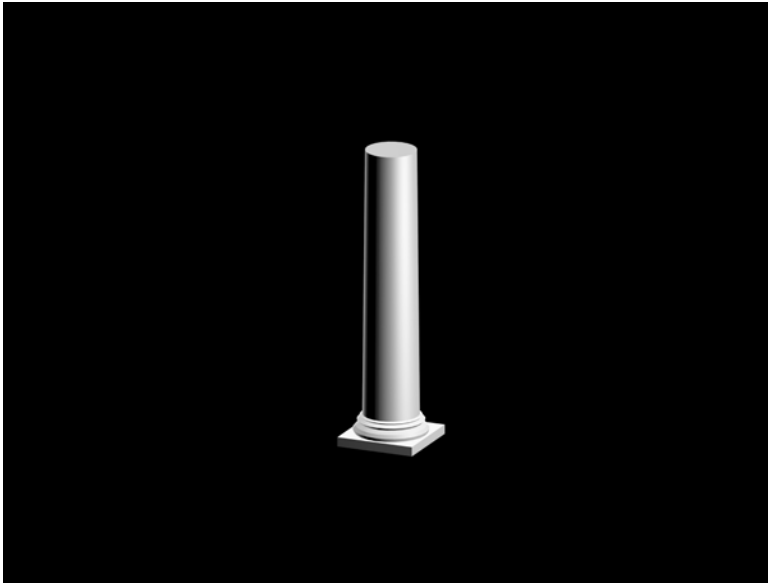
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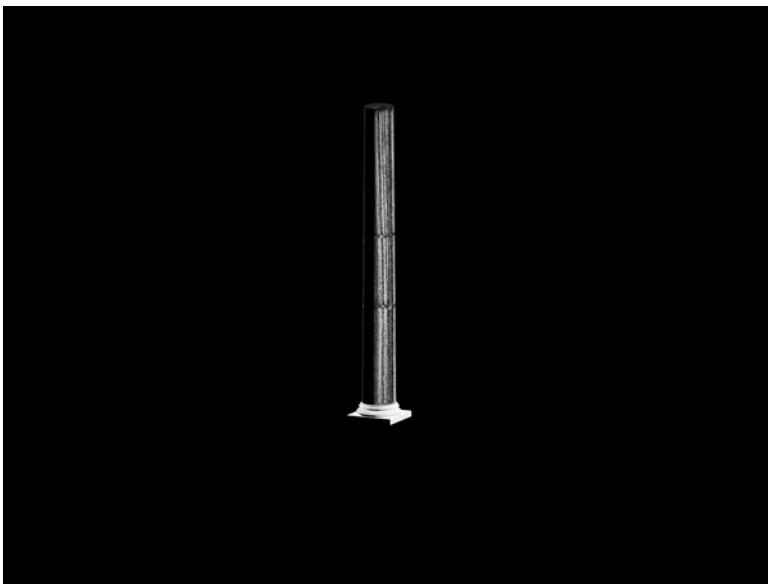
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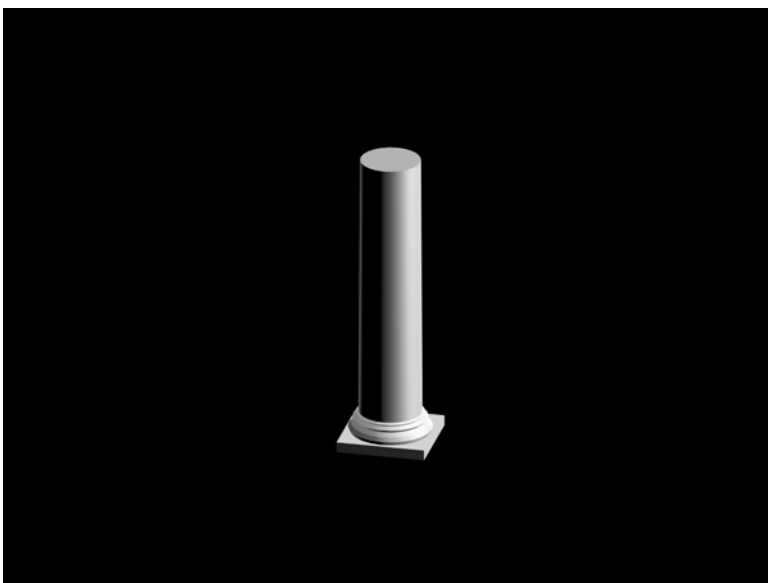
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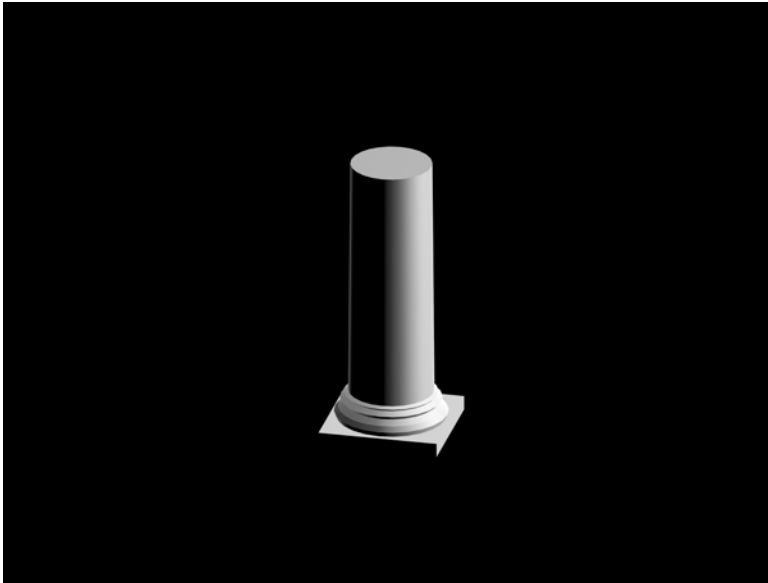
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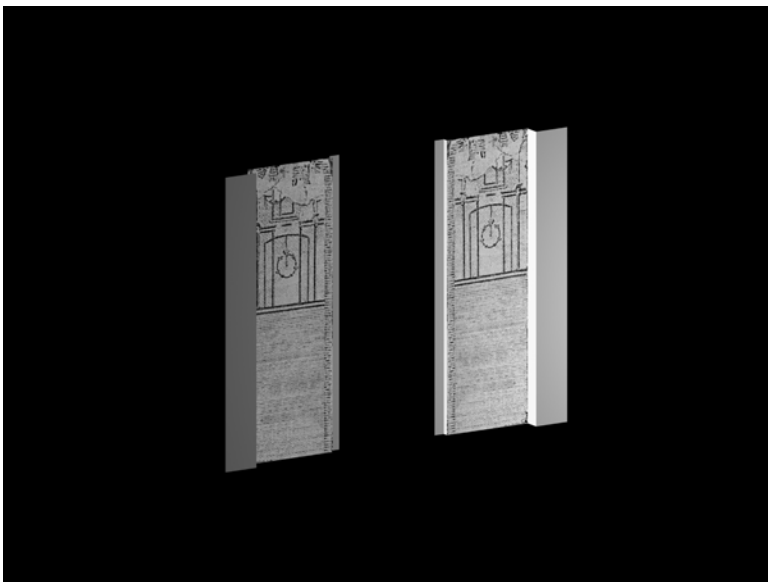
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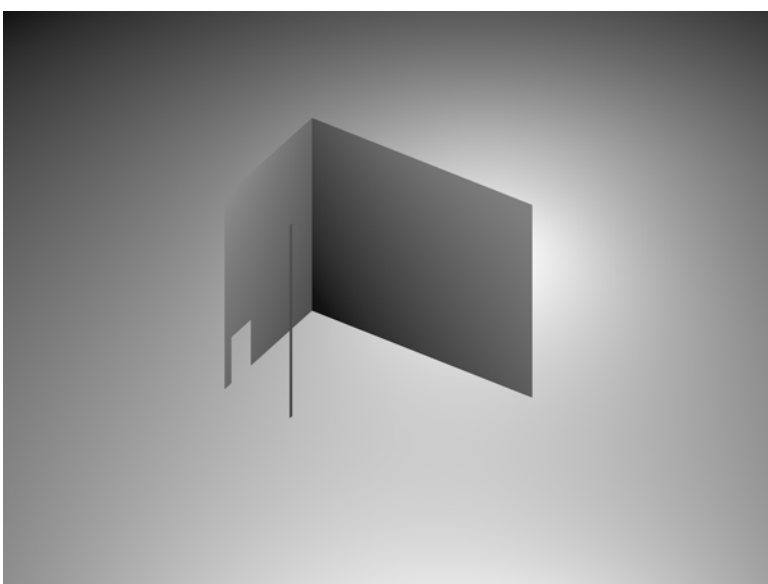
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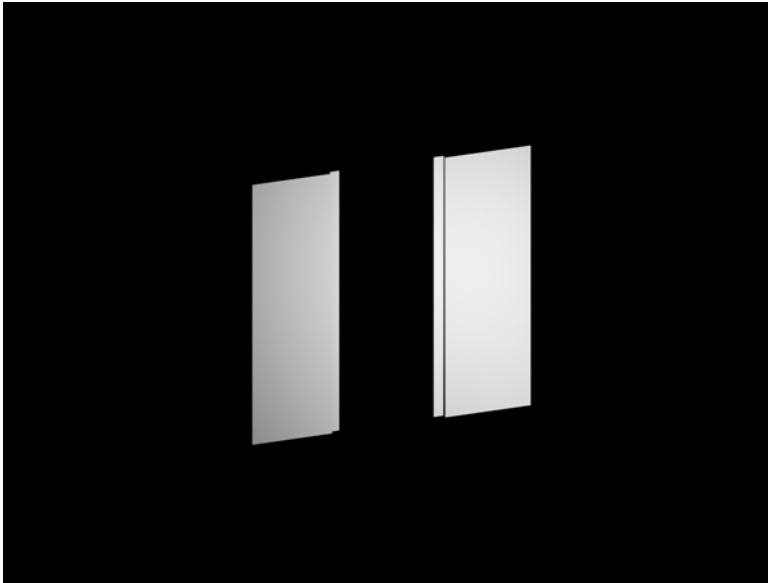
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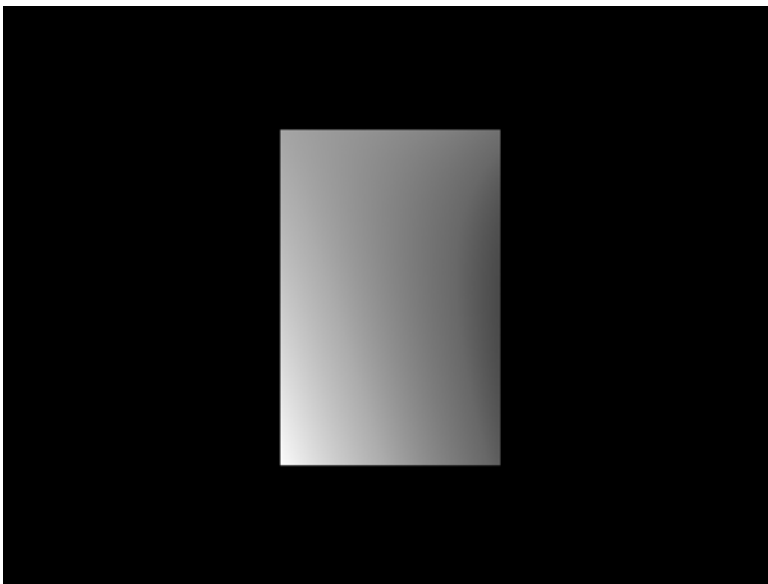
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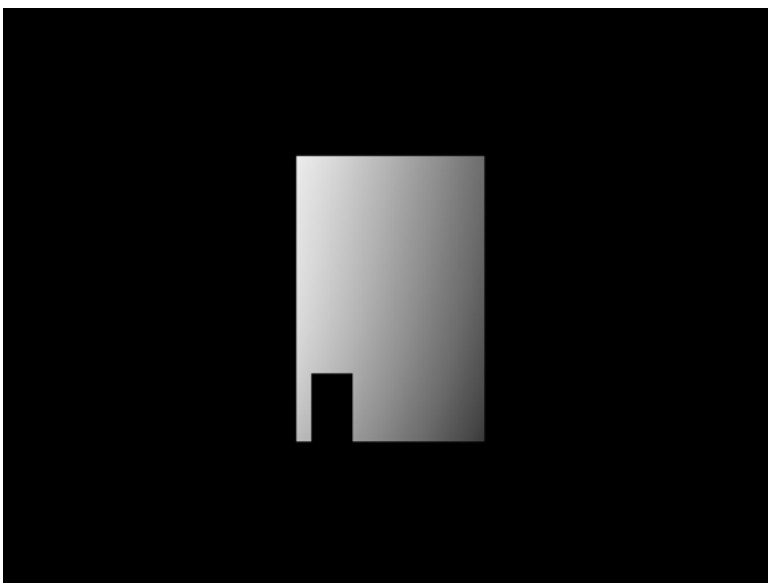
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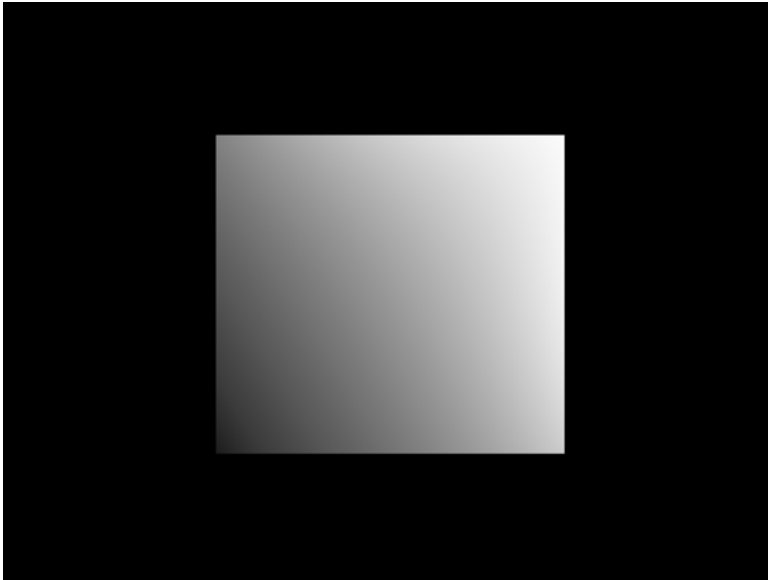
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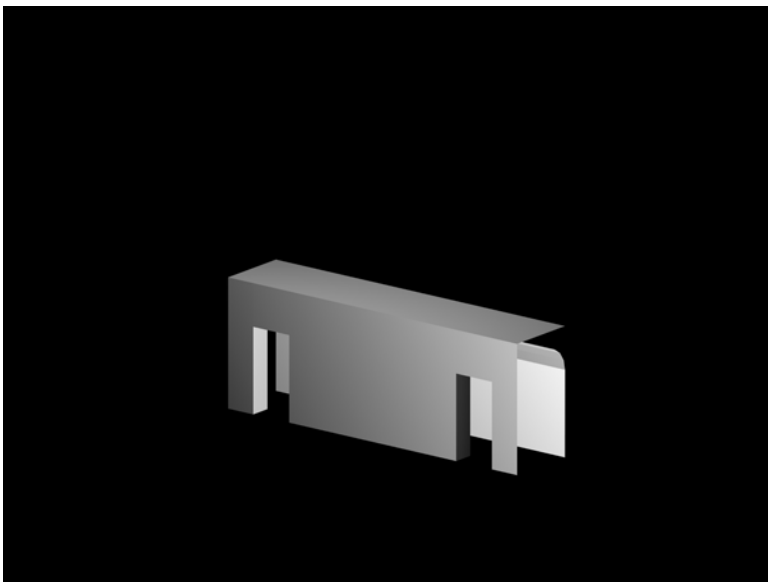
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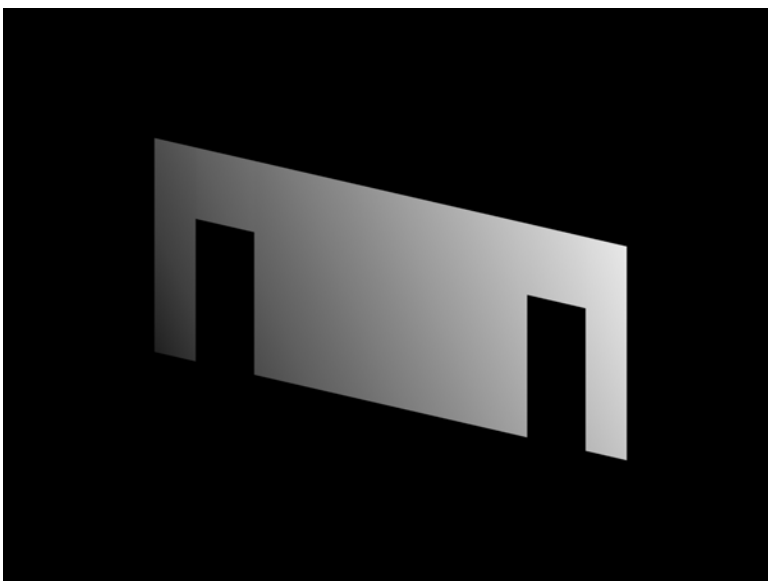
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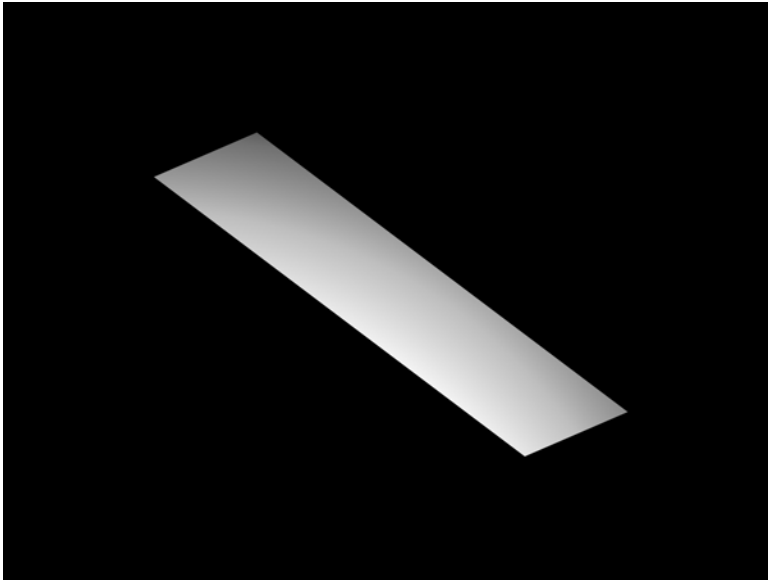
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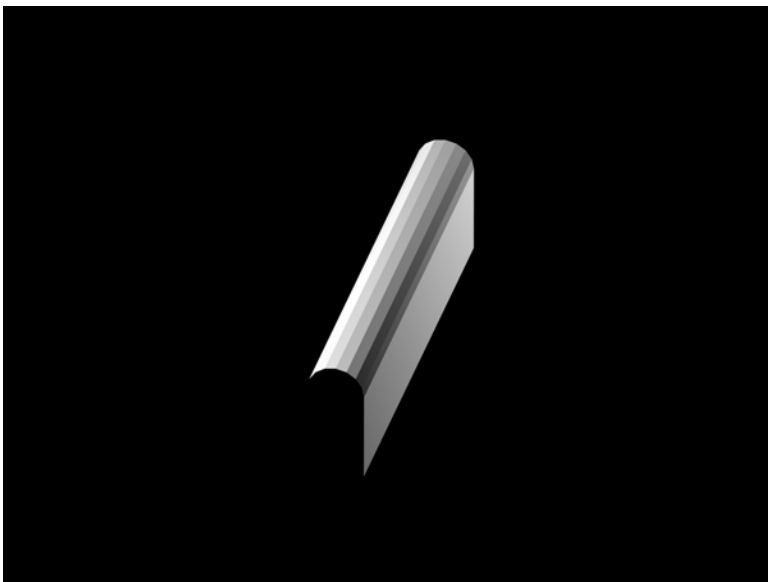
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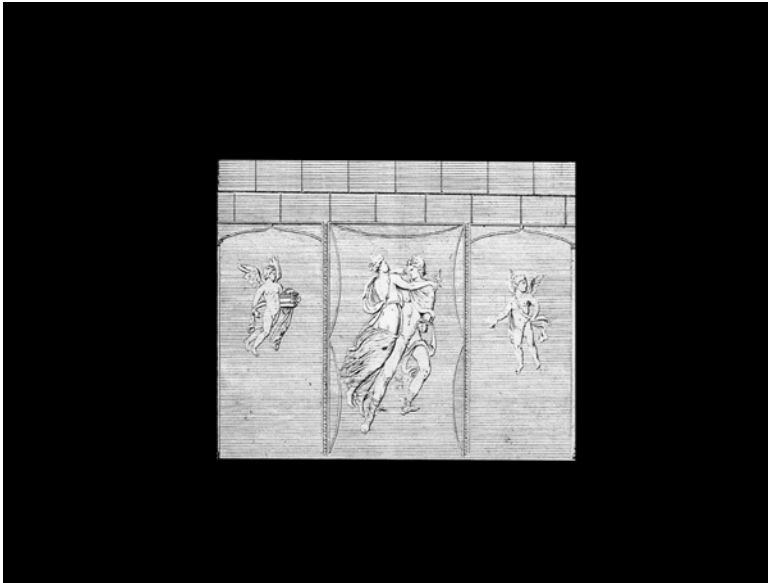
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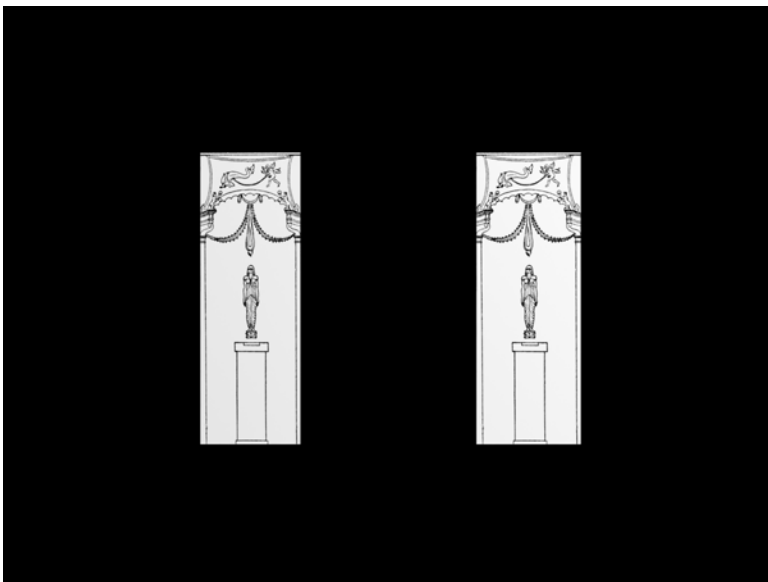
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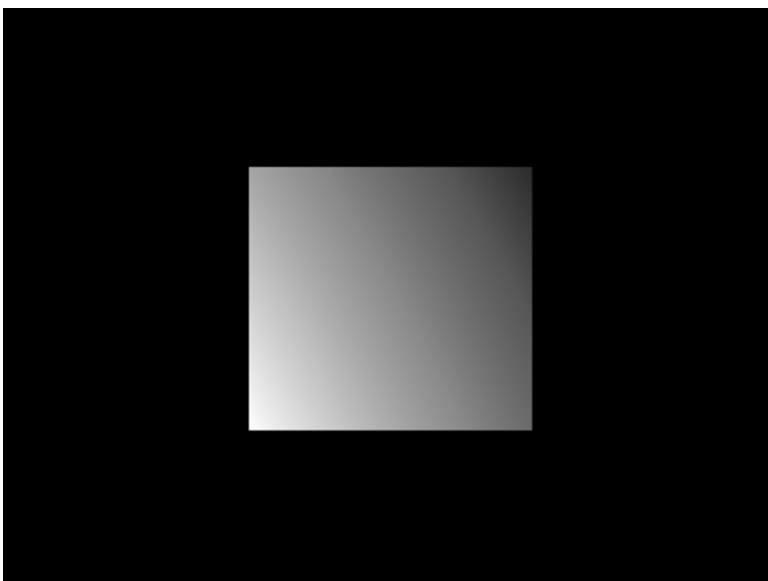
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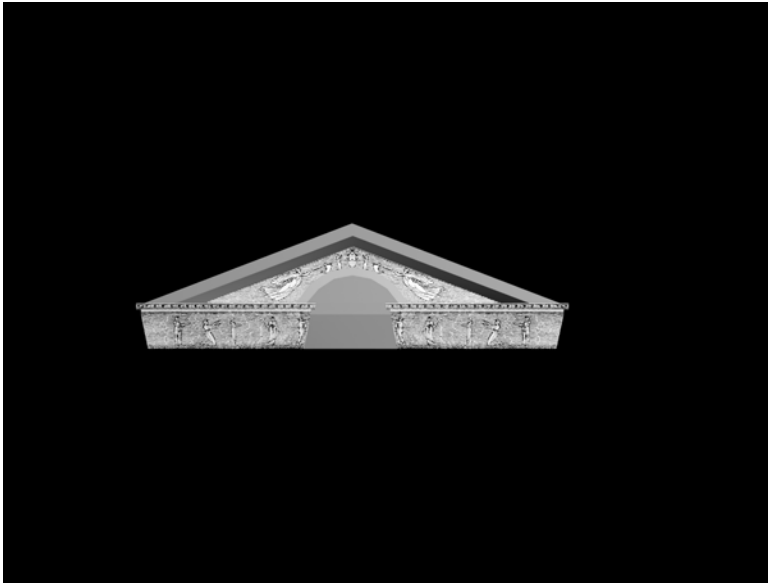
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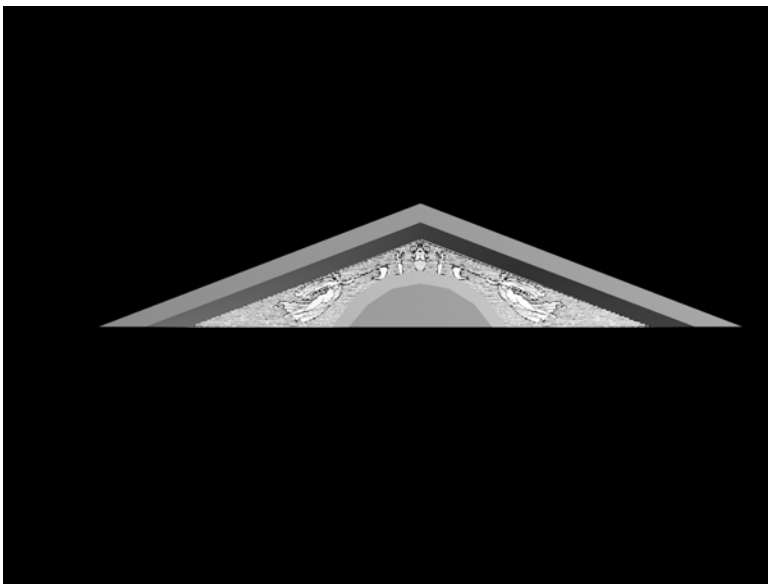
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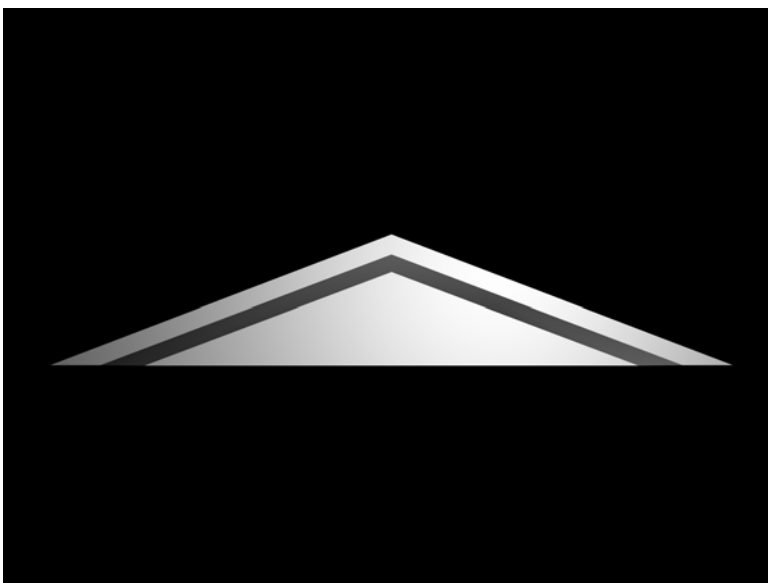
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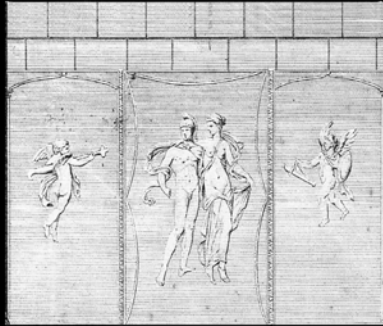
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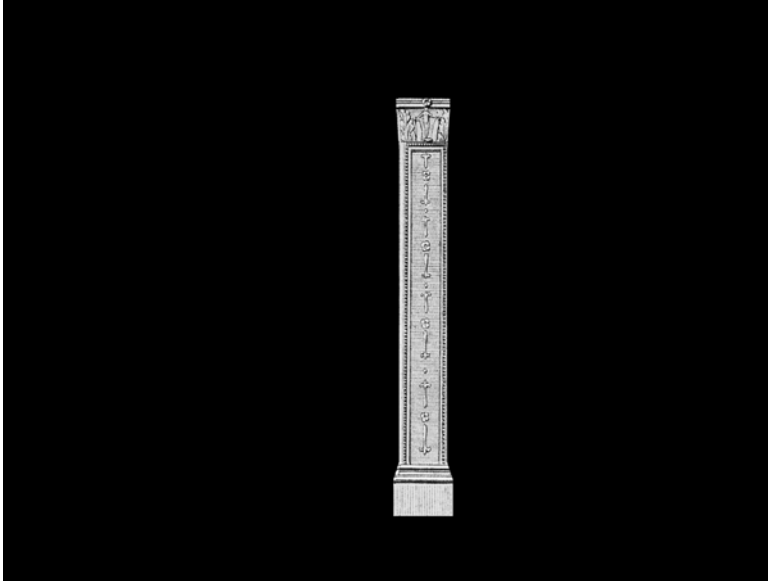
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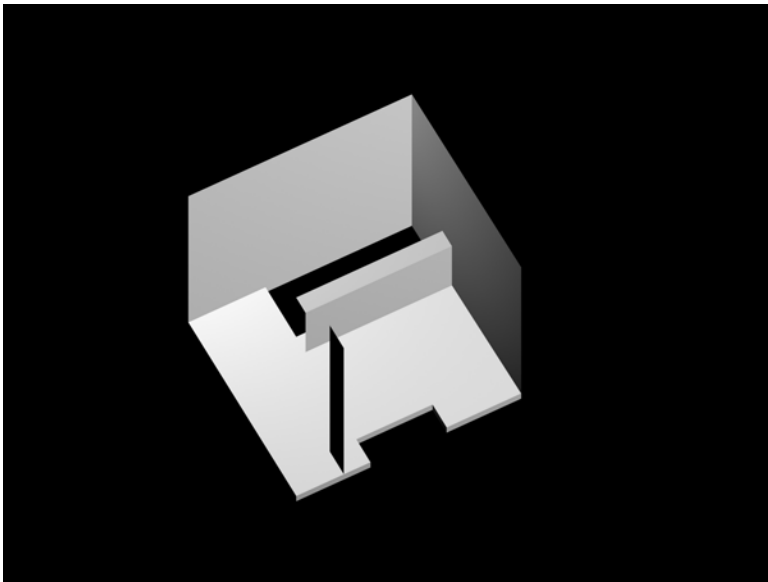
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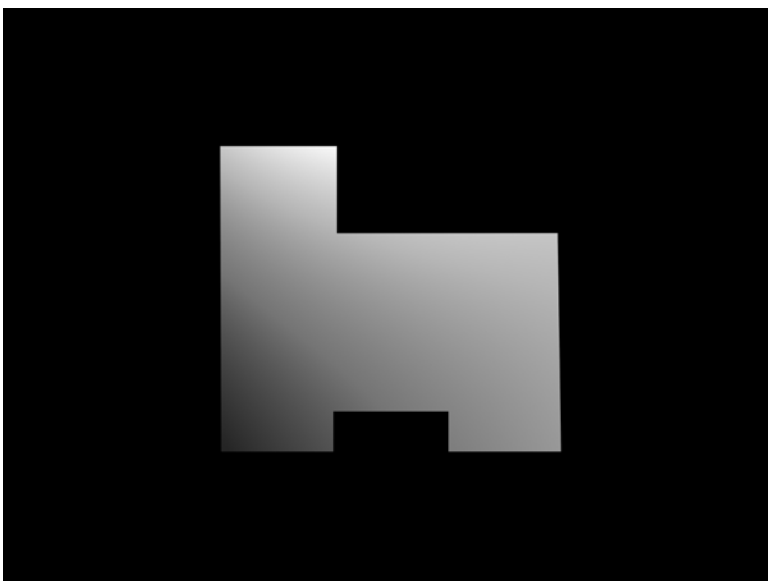
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SpT_F03_GT



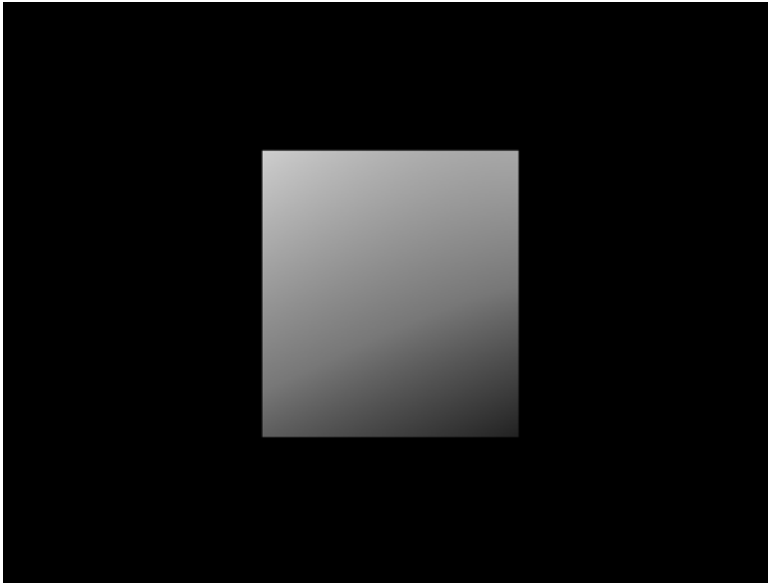
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SpaceM_GT



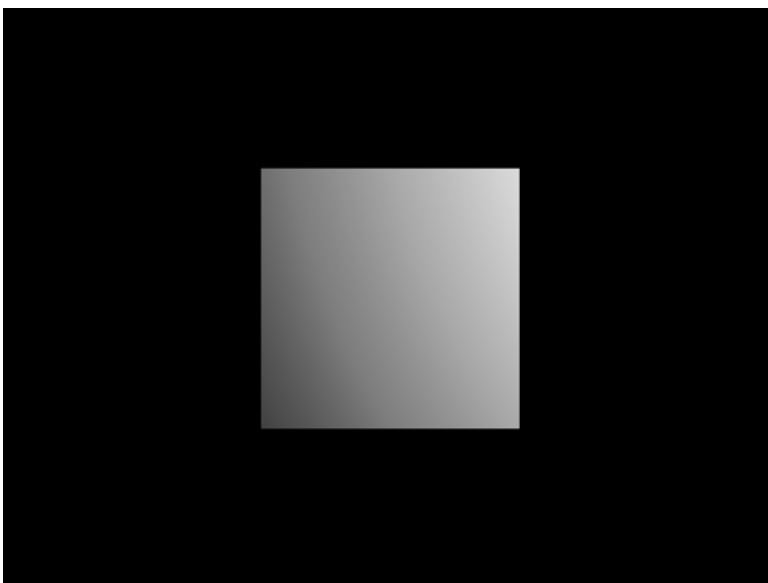
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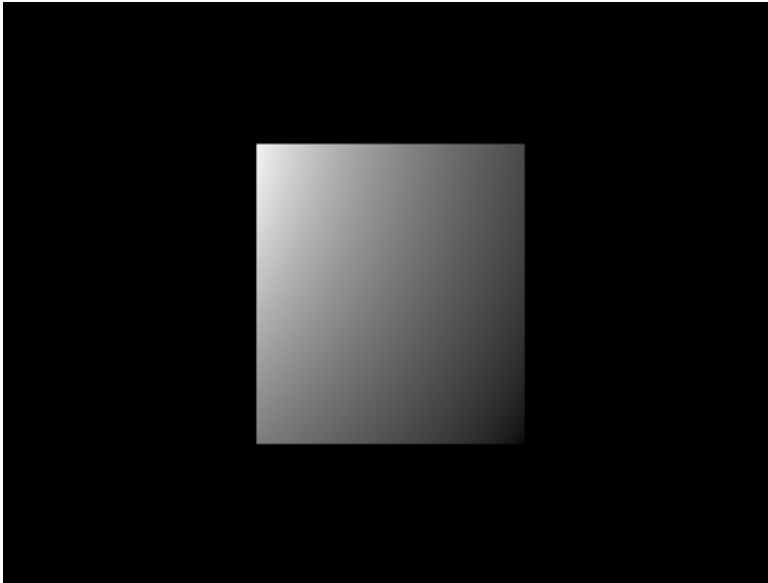
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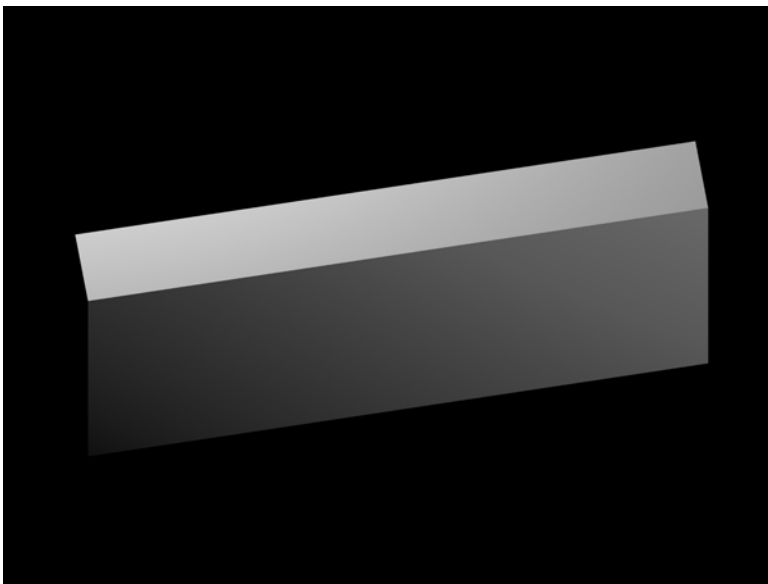
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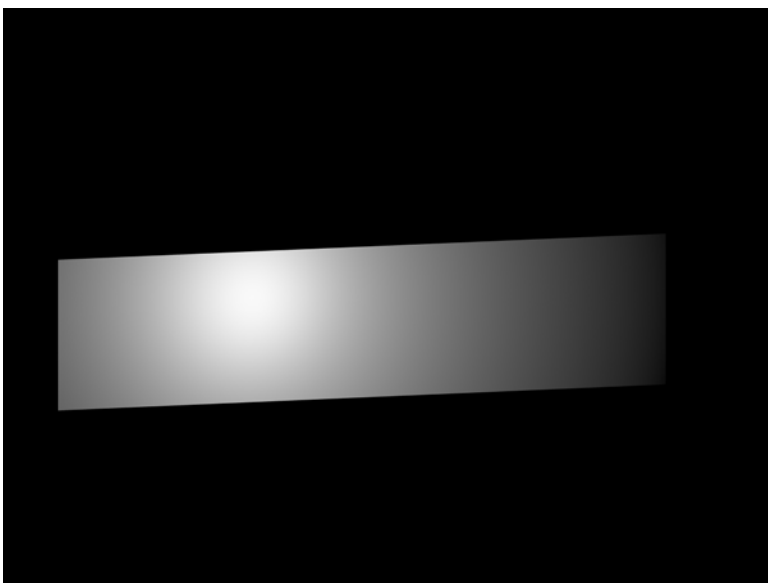
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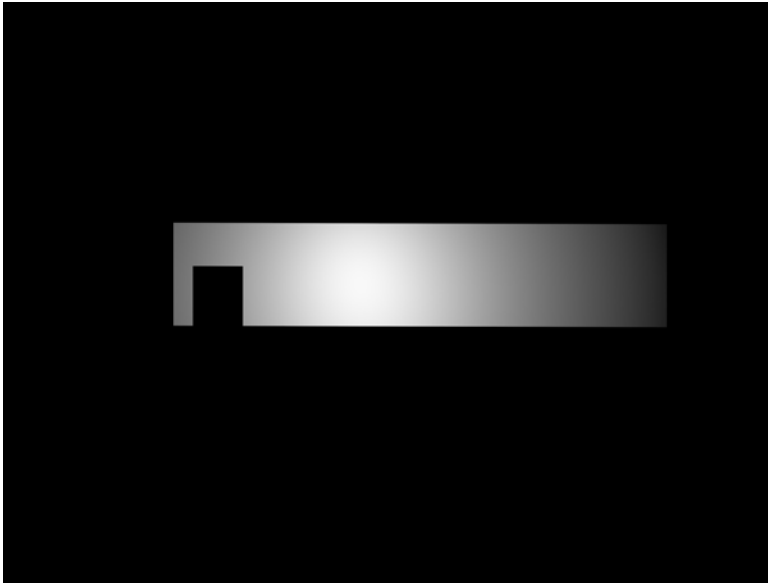
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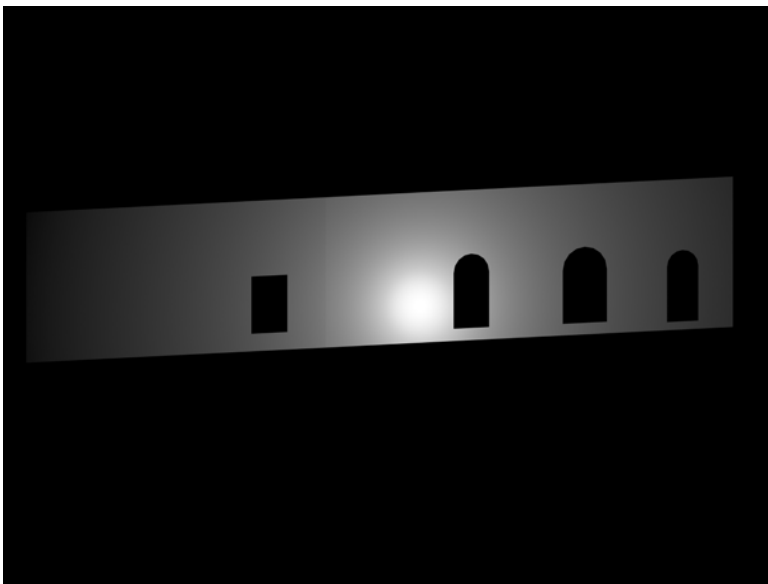
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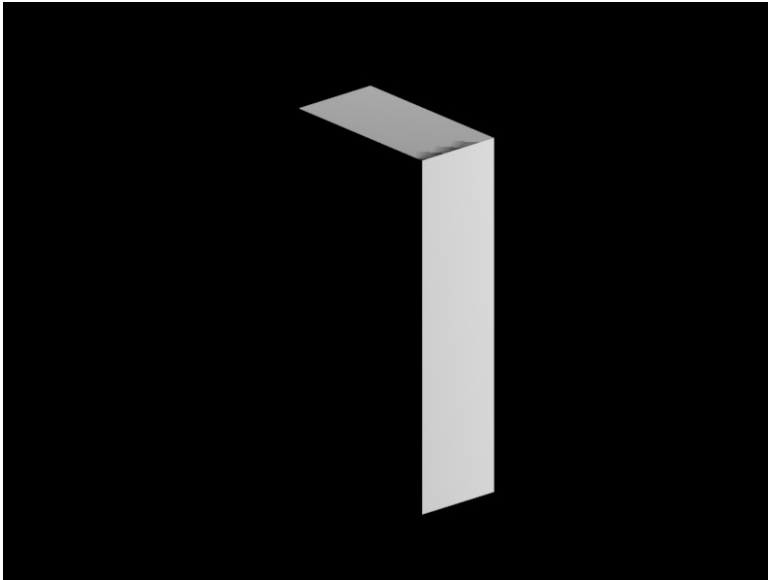
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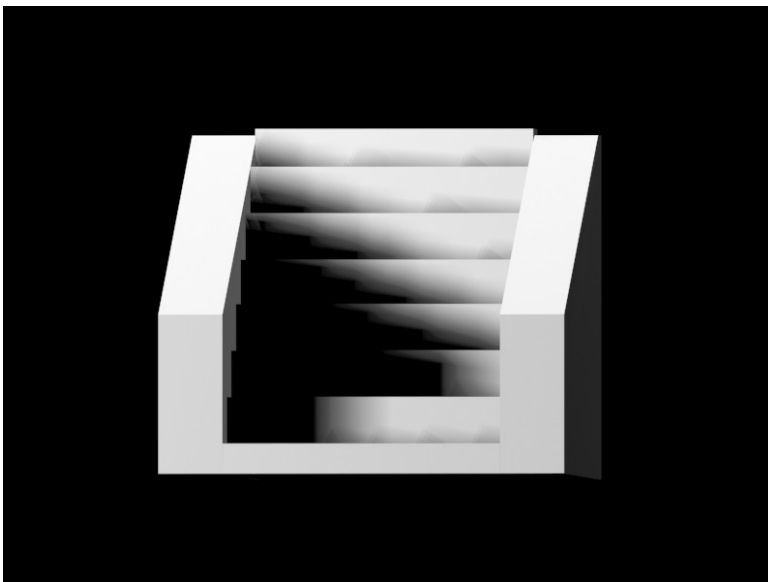
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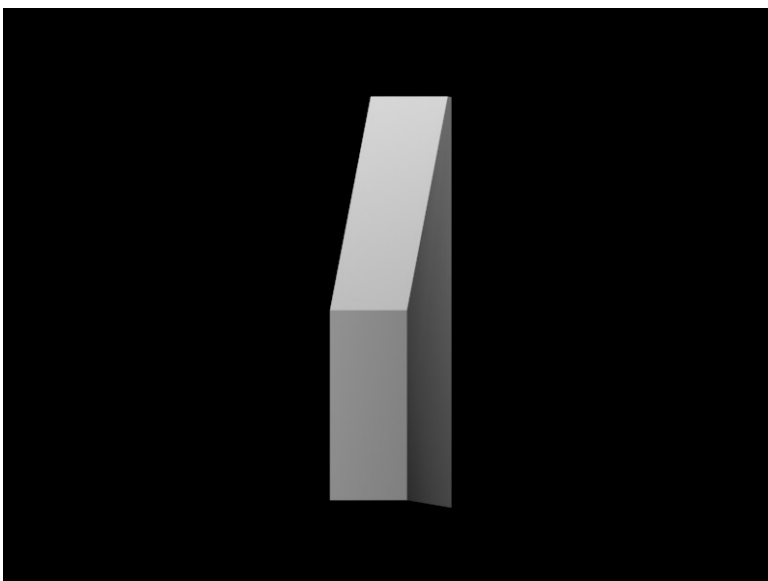
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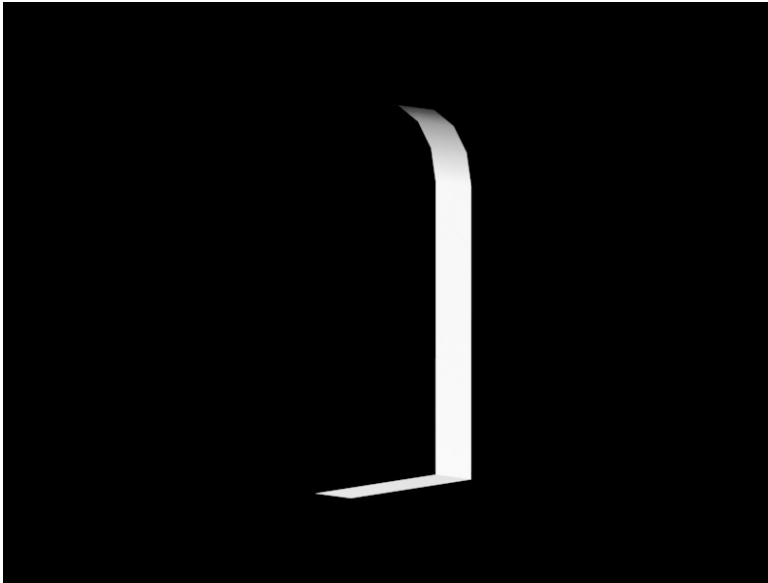
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TrJ_to_I02_GT



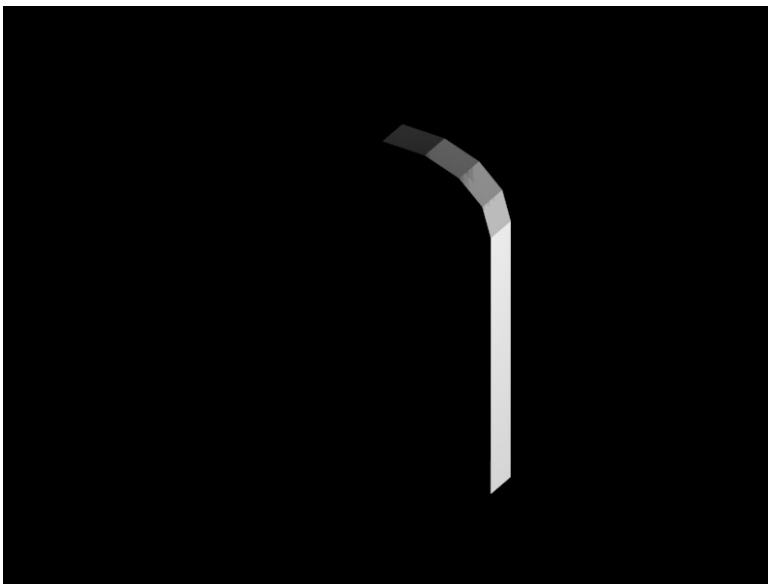
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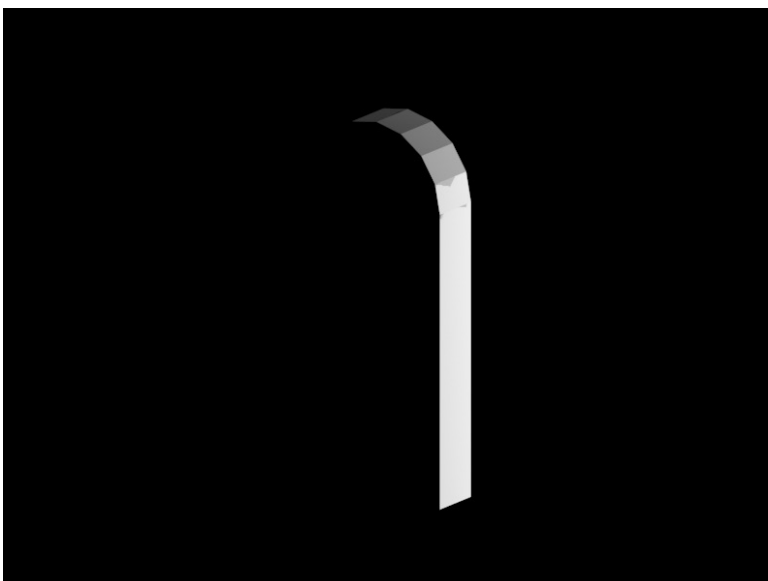
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TrA_to_C_F02_GT



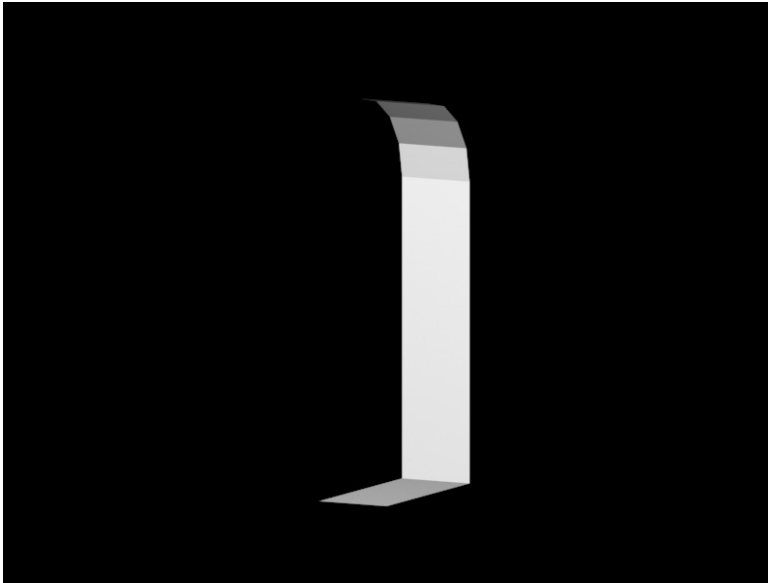
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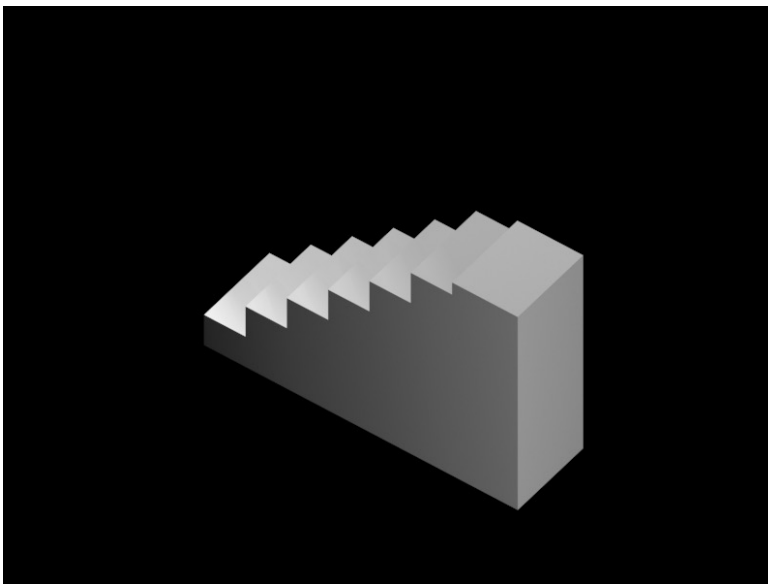
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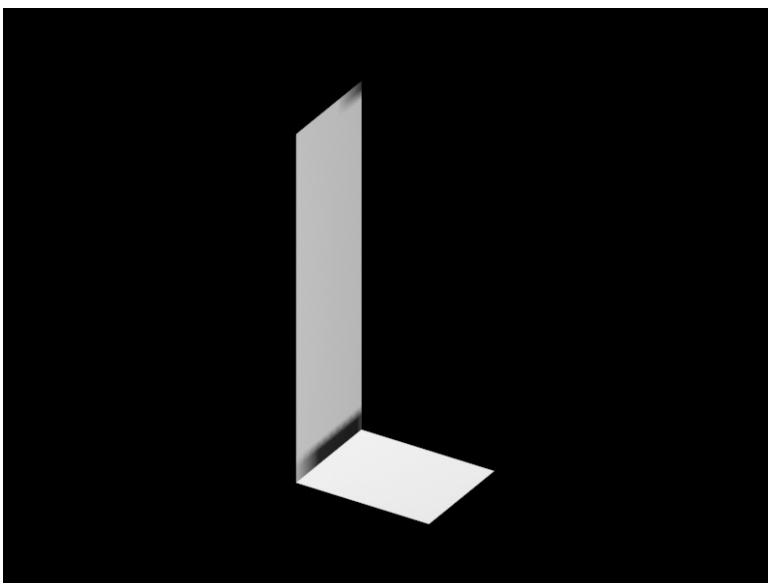
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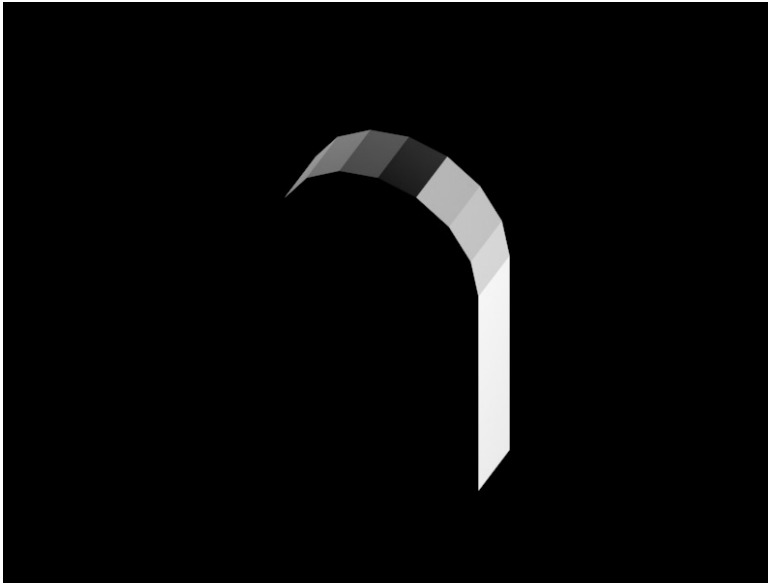
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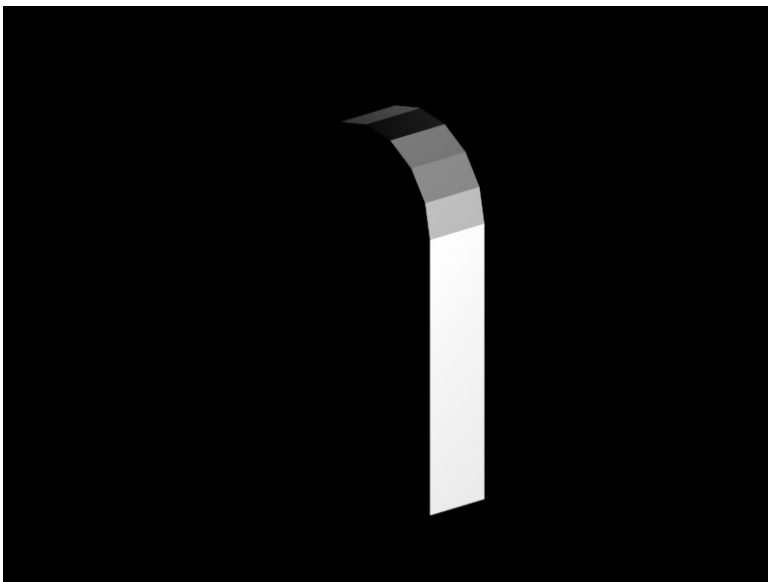
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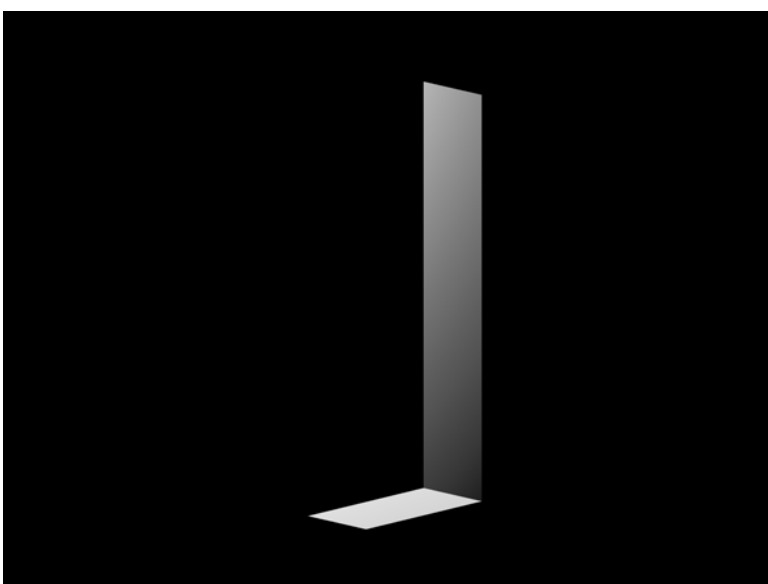
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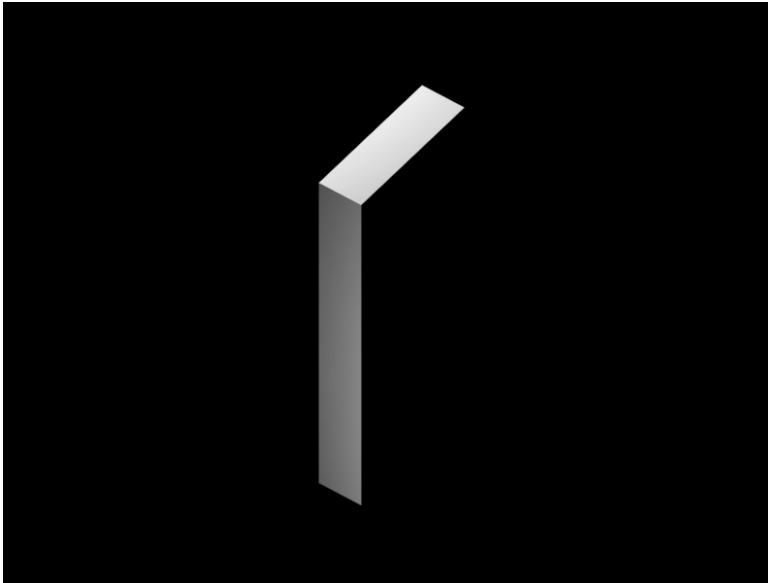
TrA_to_R_GT



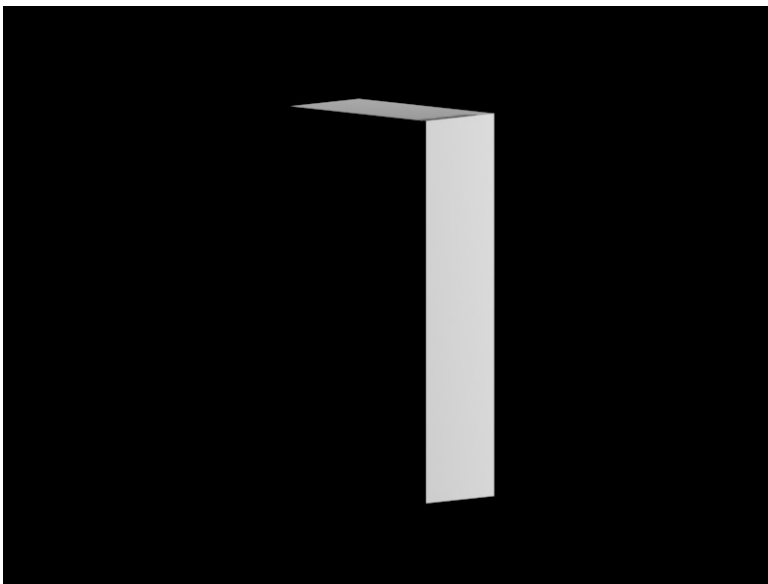
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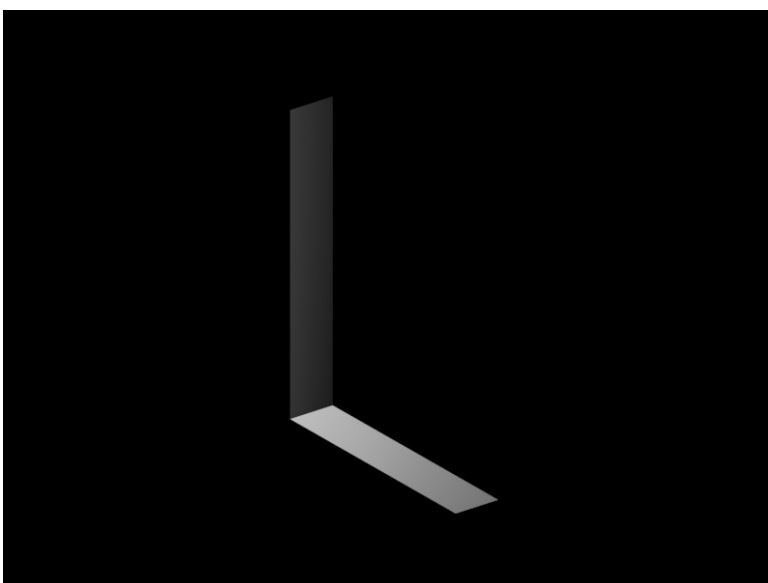
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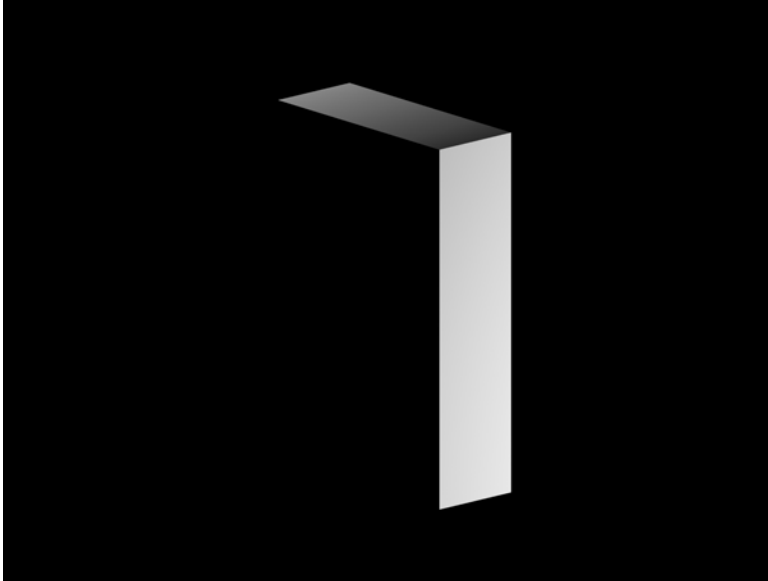
TrH_to_I_GT



TrH_to_J01_GT and
TrH_to_J02_GT

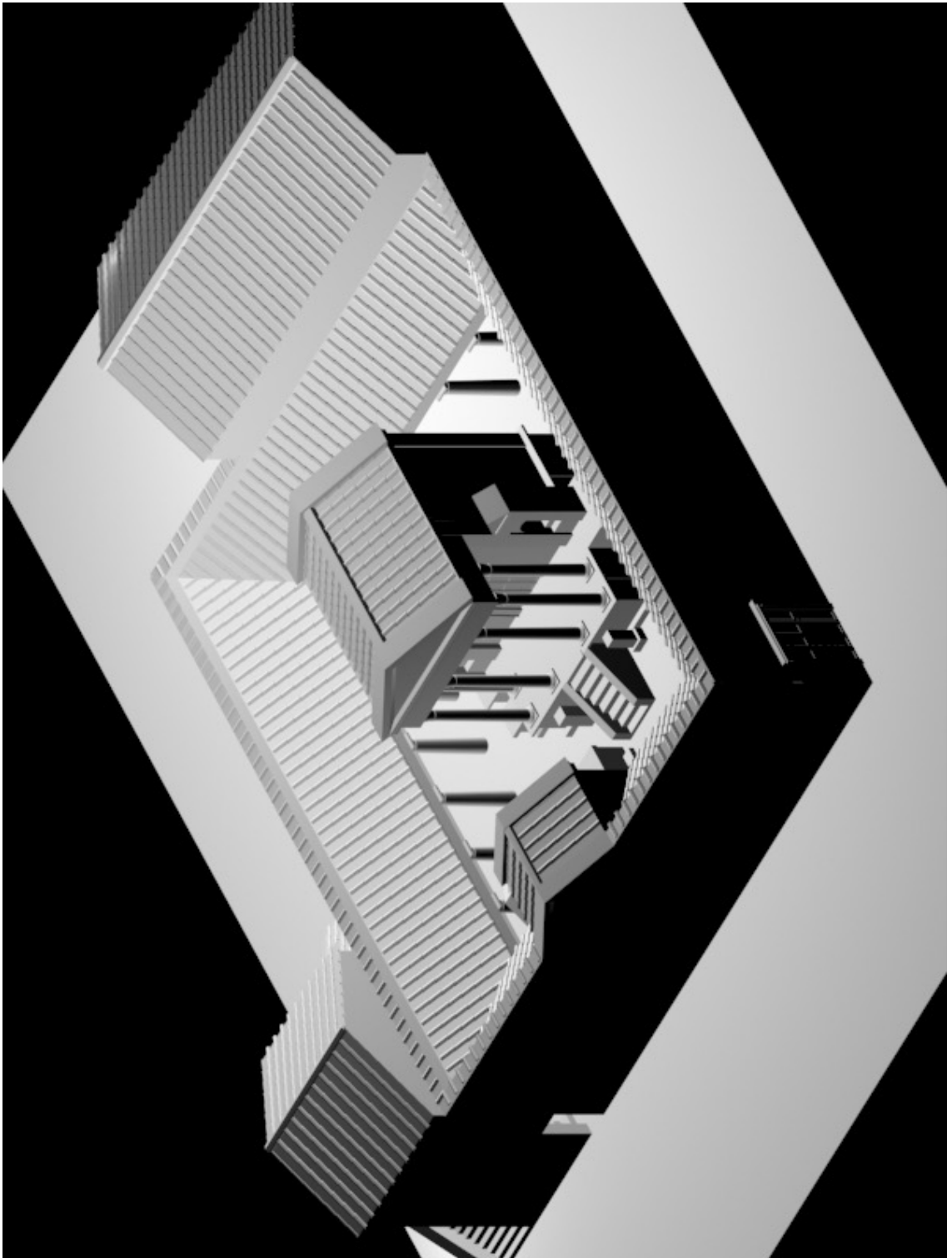


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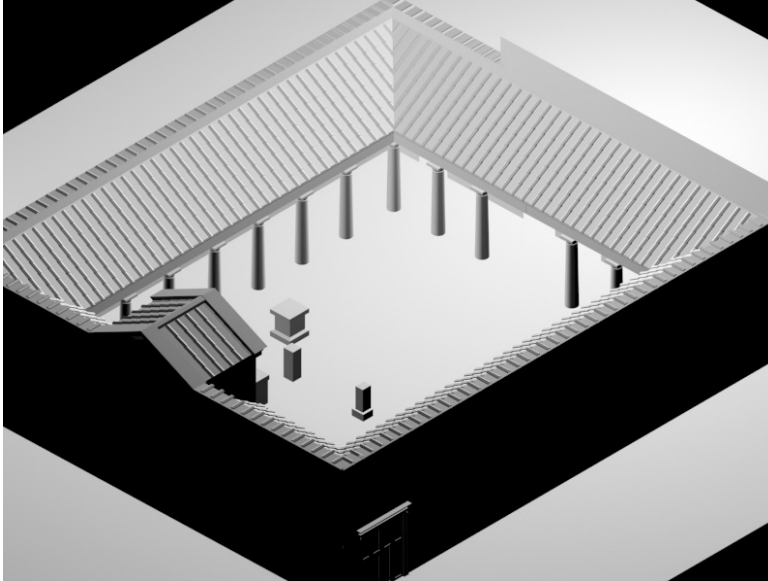


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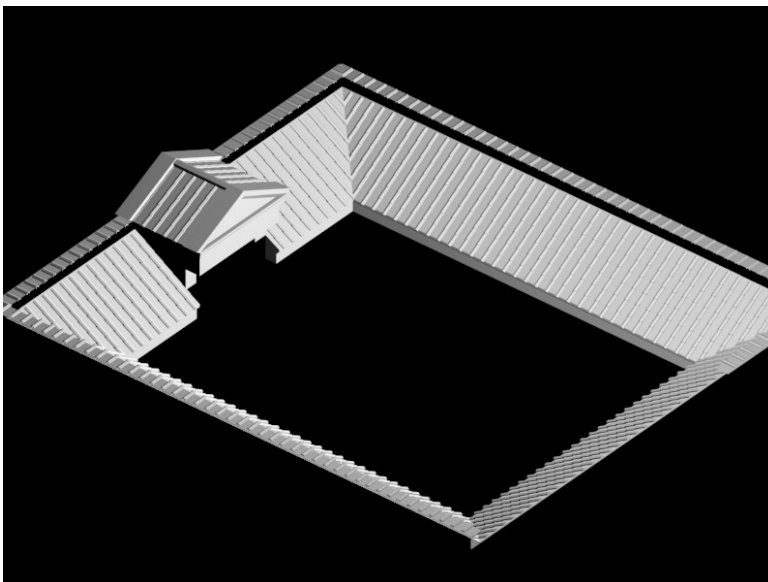
E.2. Iseum79



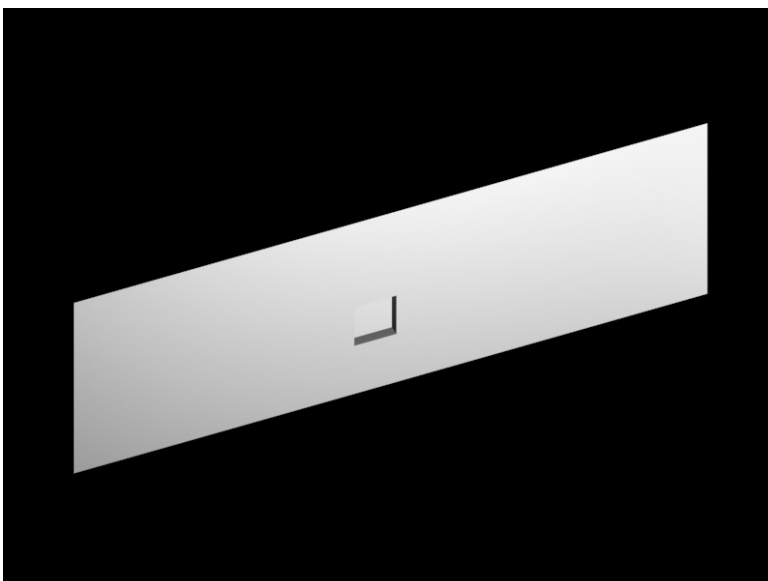
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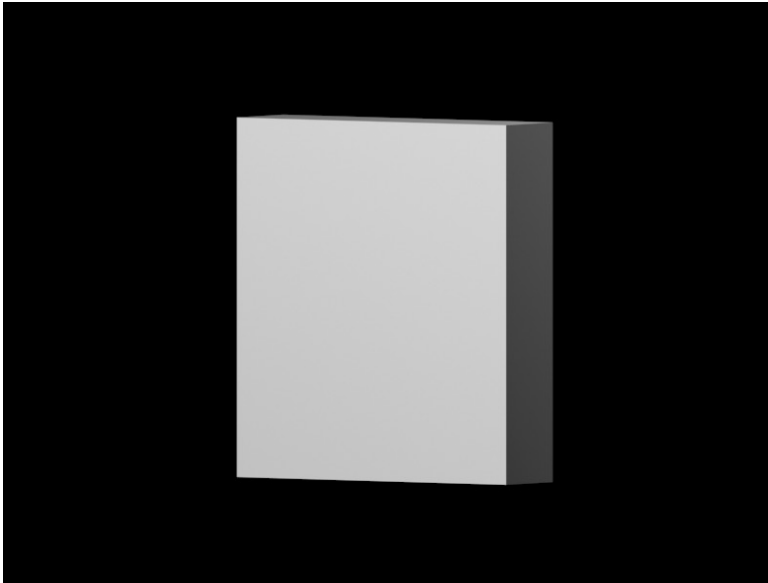
SpaceA_79



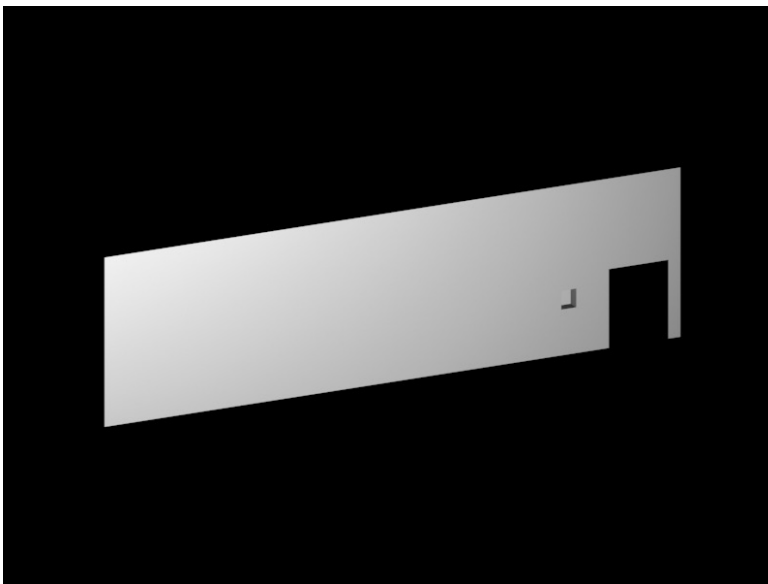
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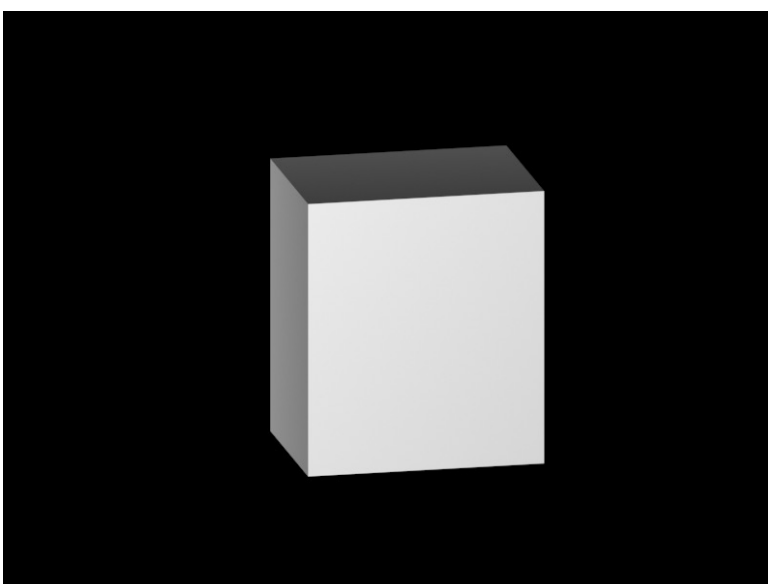
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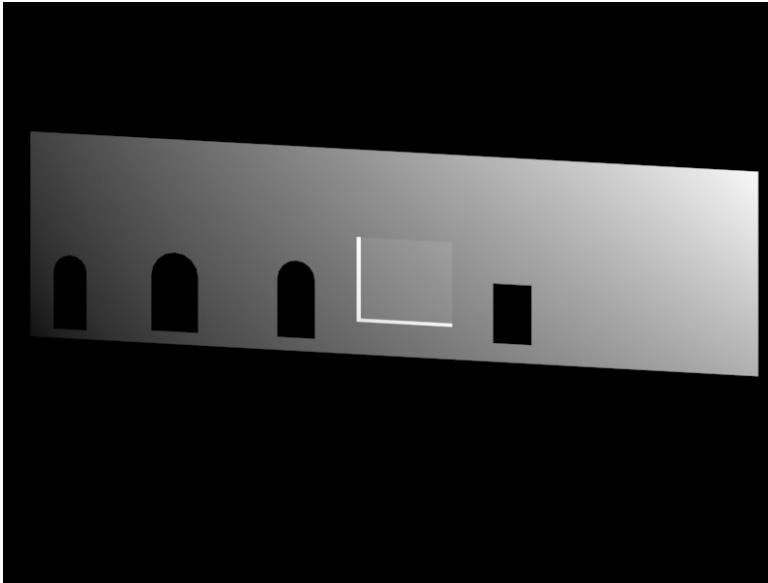
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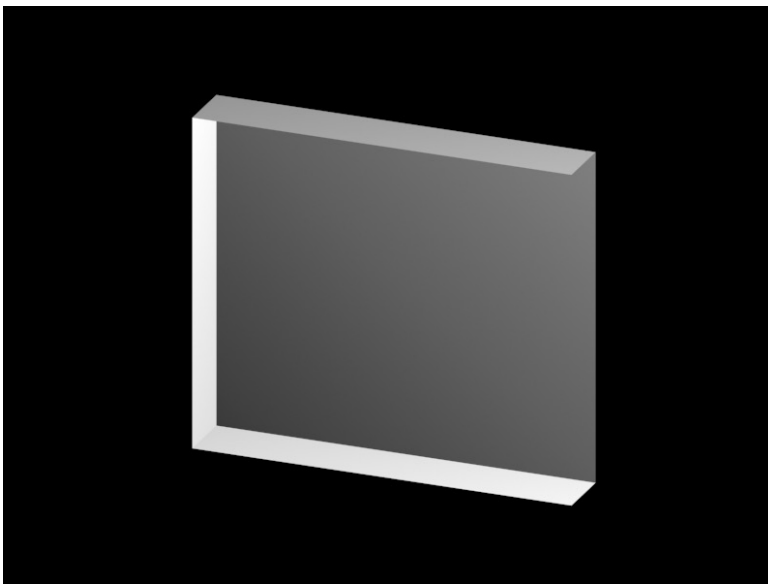
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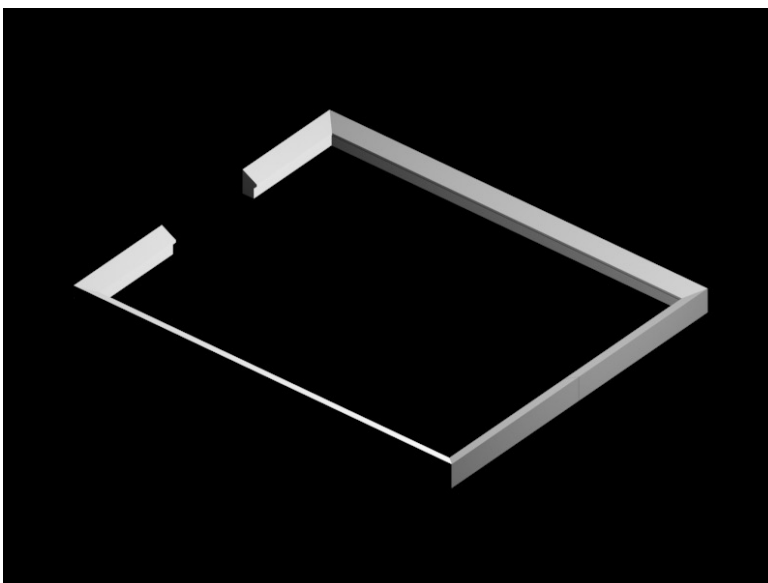
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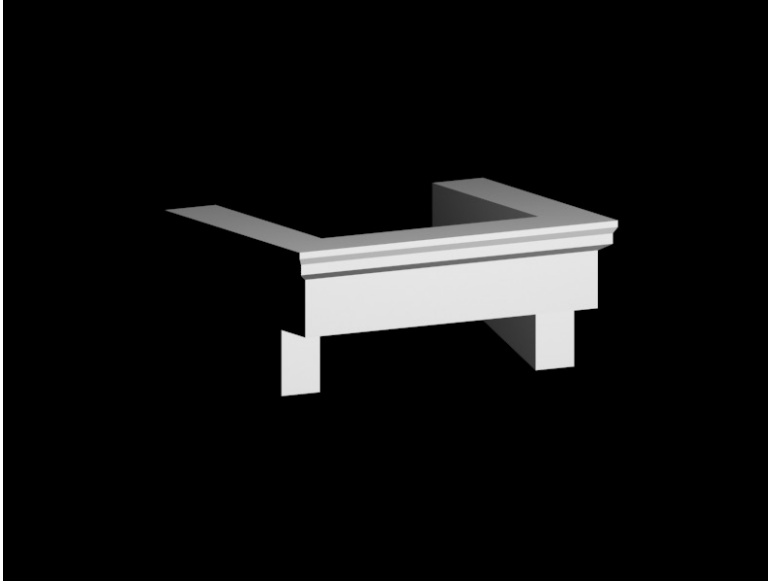
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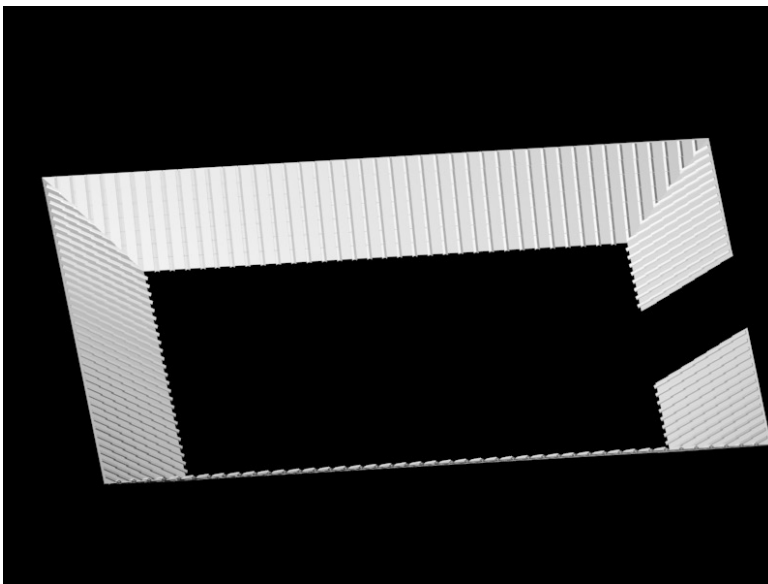
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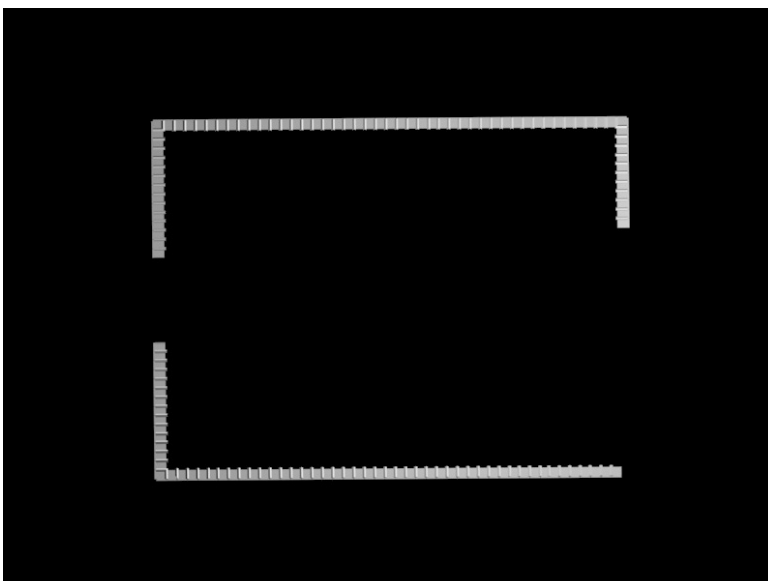
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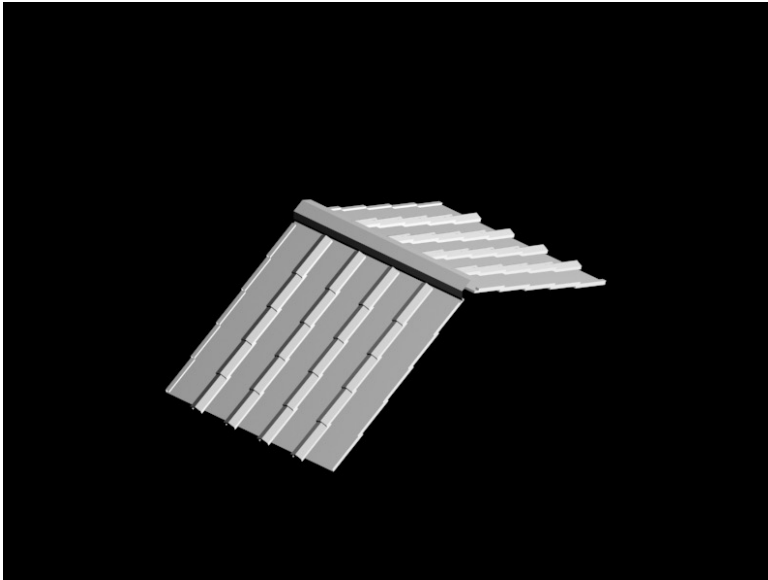
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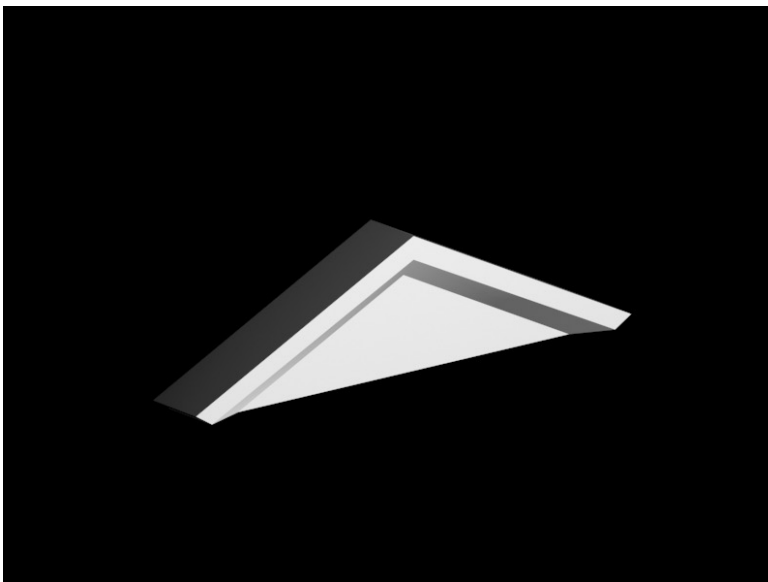
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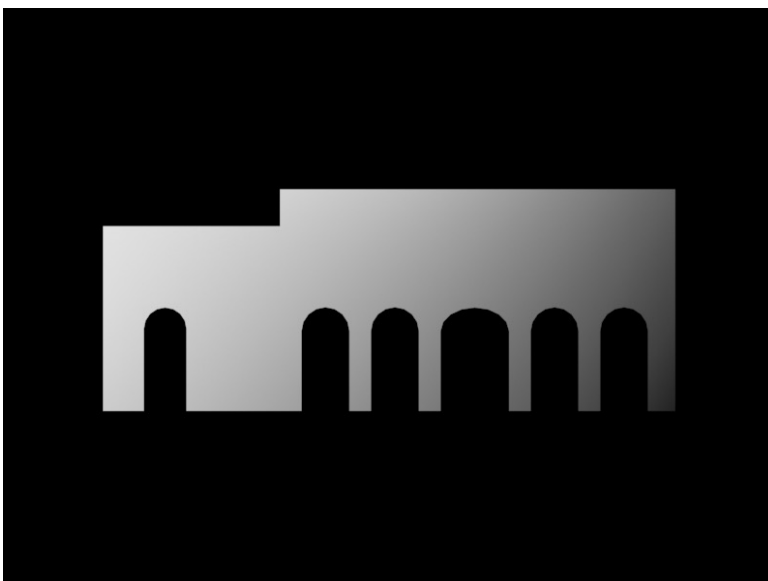
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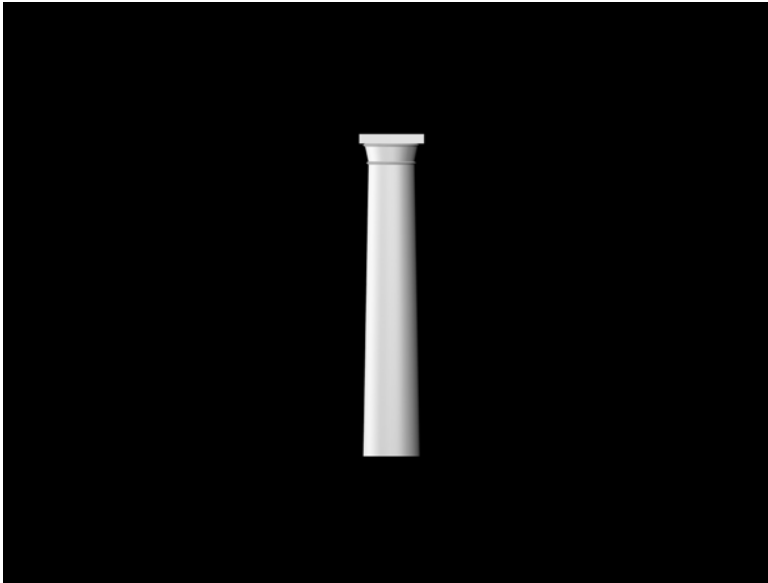
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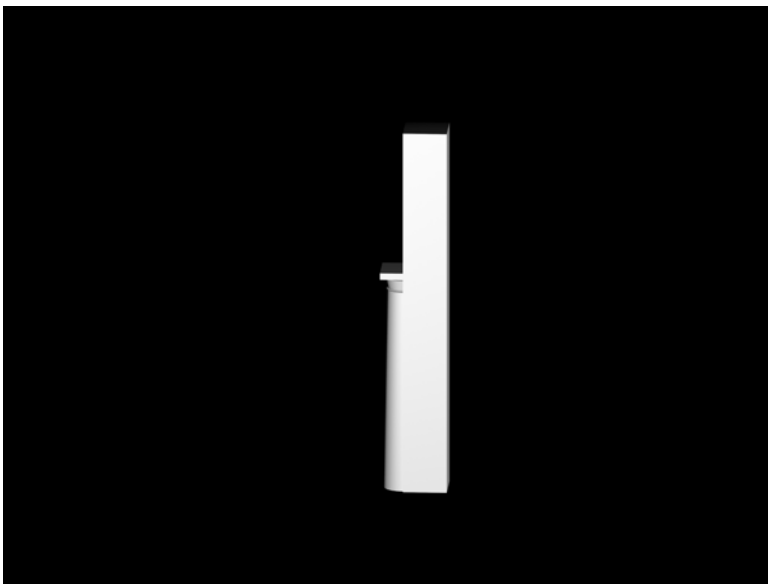
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SpA_CoU_F07_79



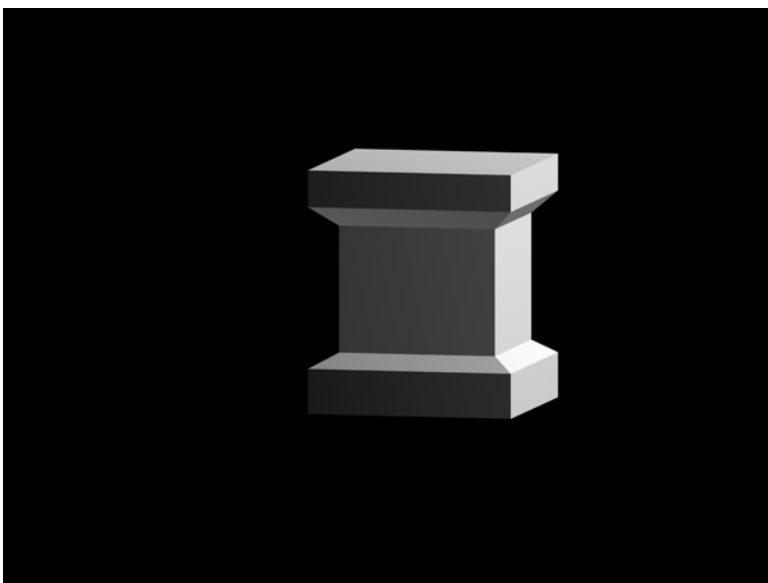
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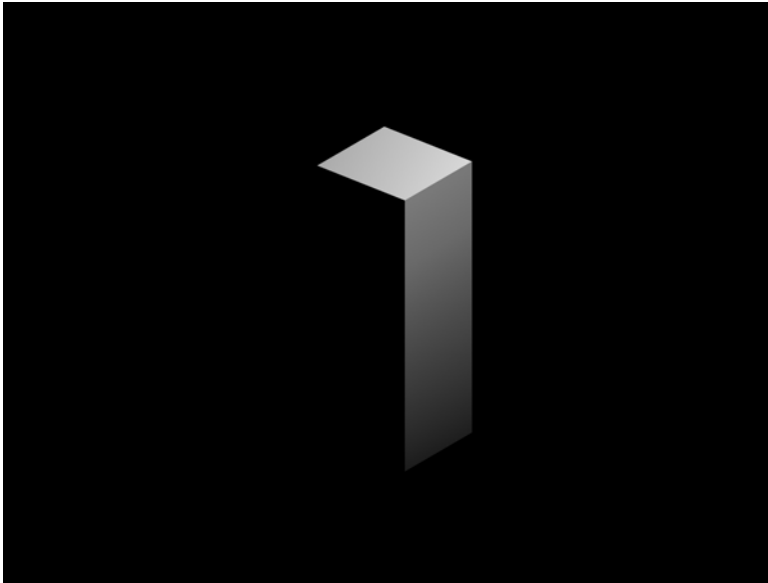
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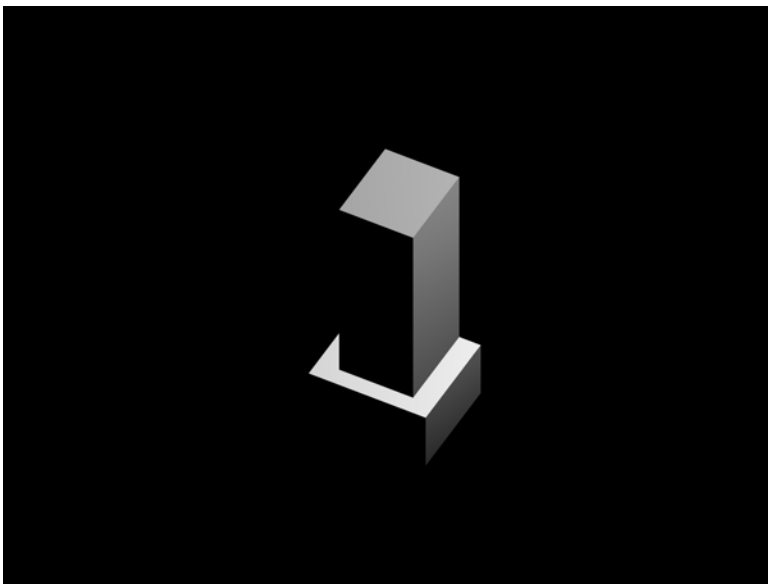
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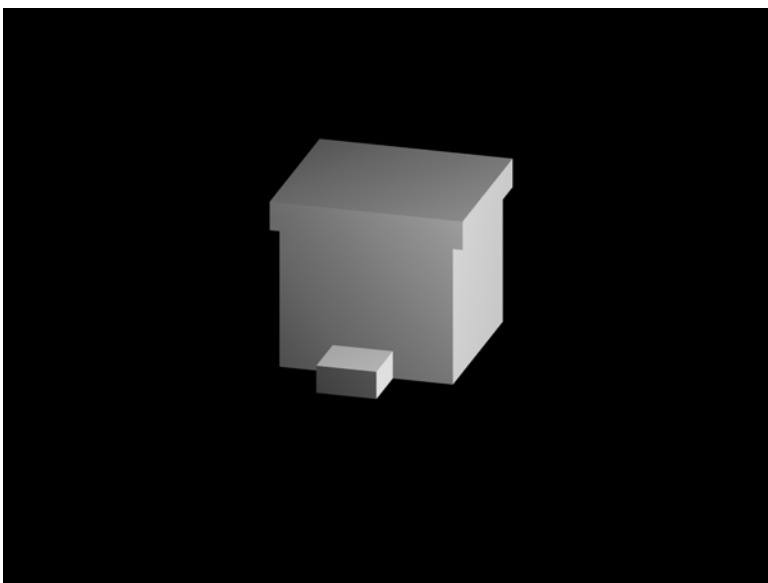
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SpA_F26_79



SpA_F27_79



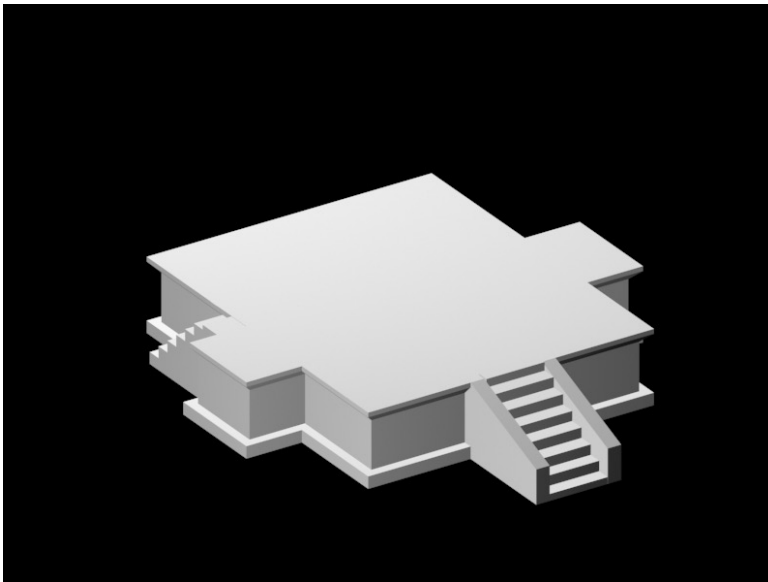
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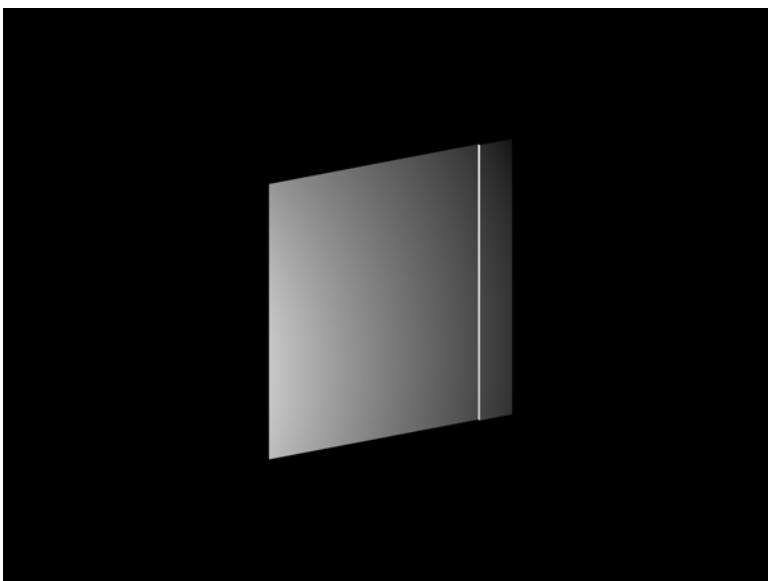
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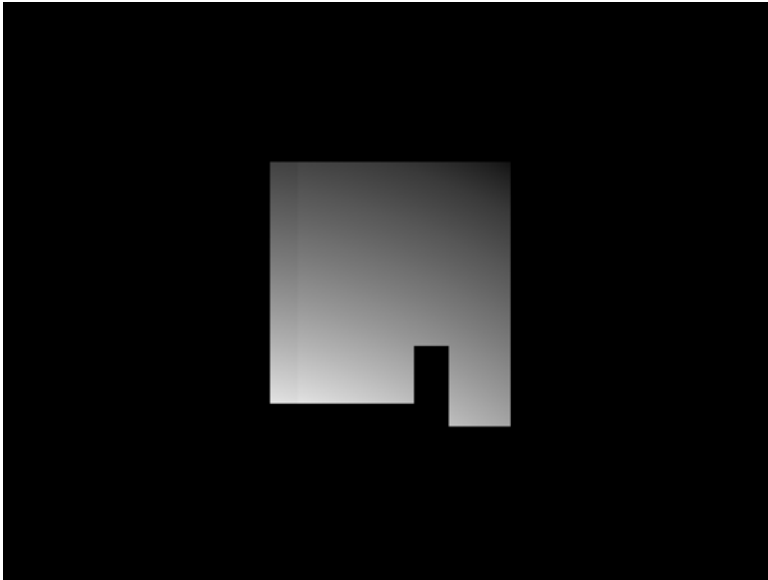
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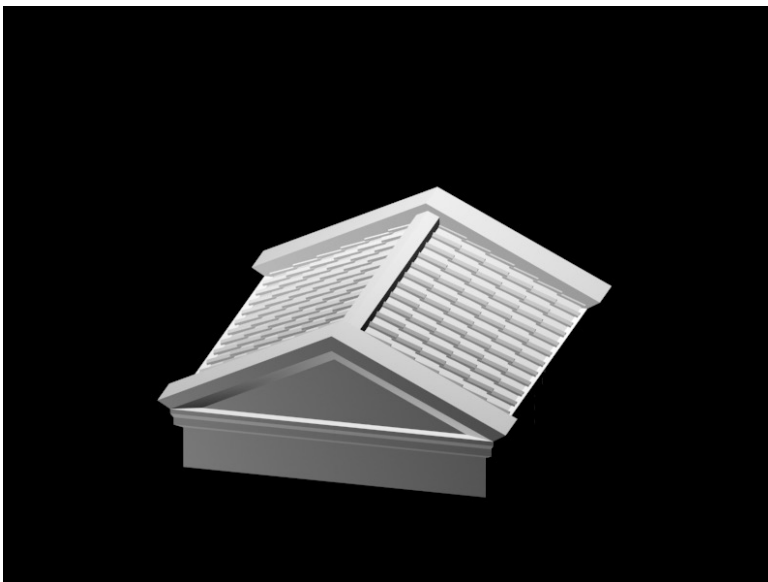
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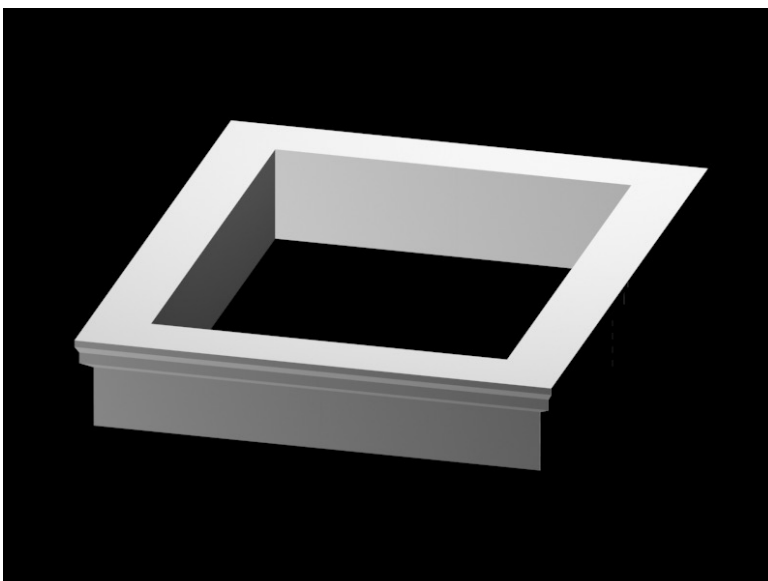
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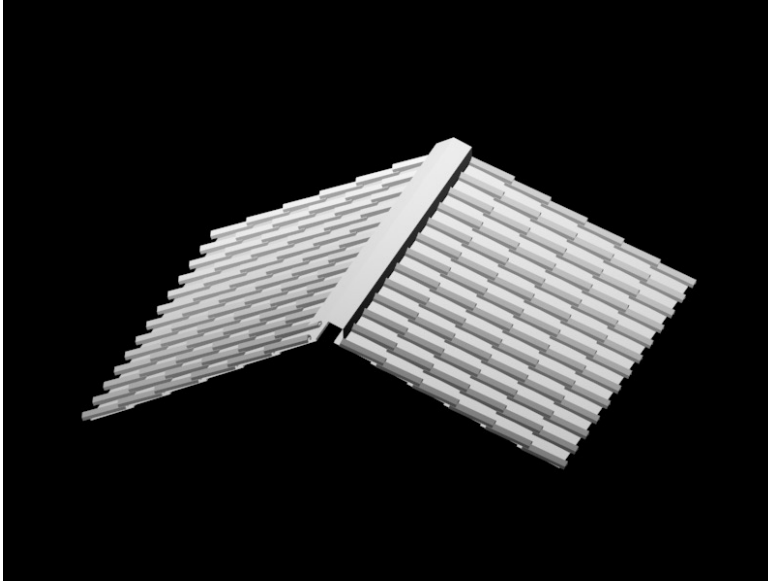
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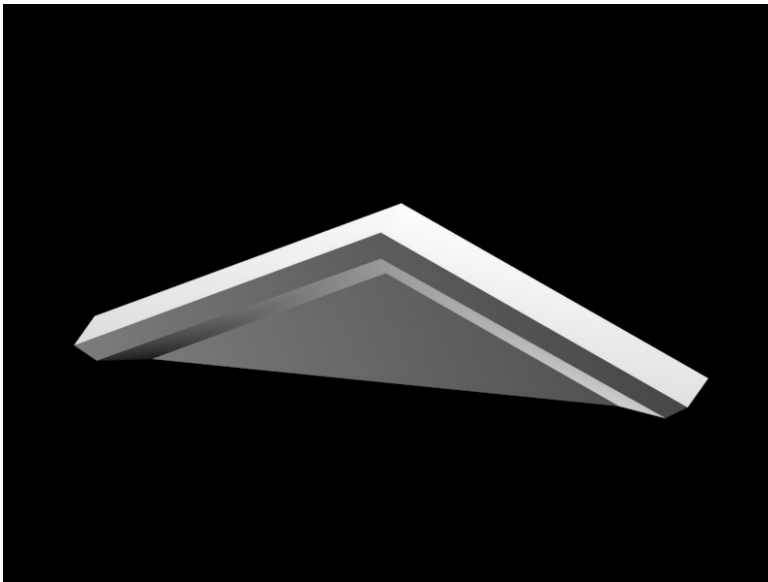
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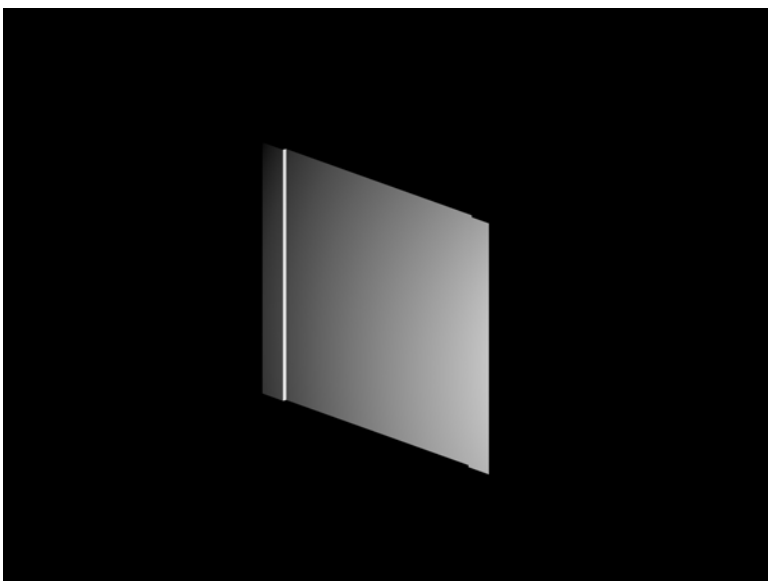
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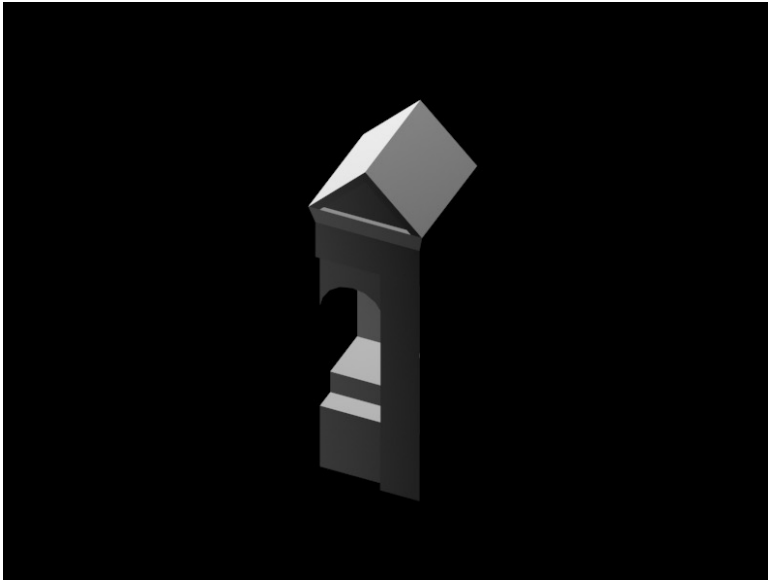
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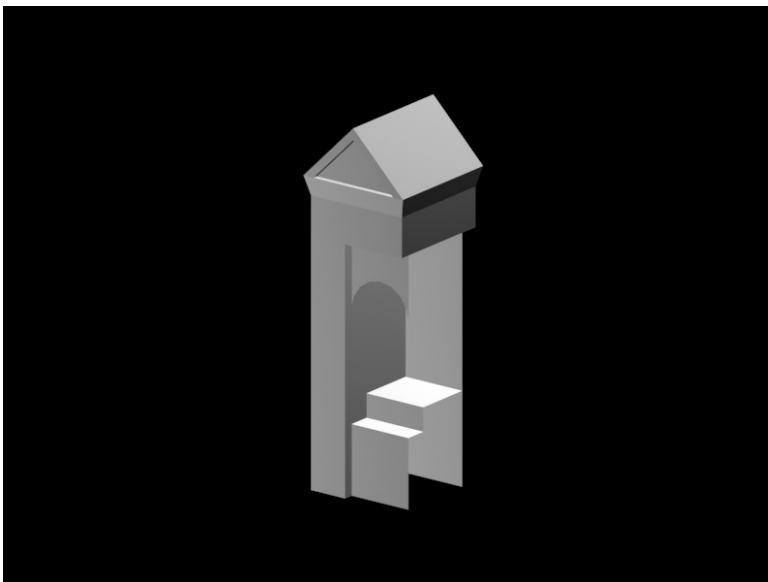
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SpC_CoU_F04_79



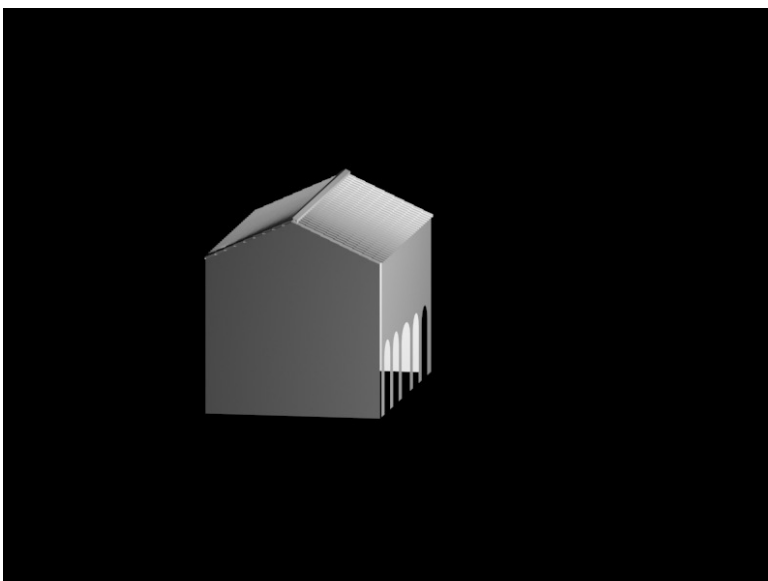
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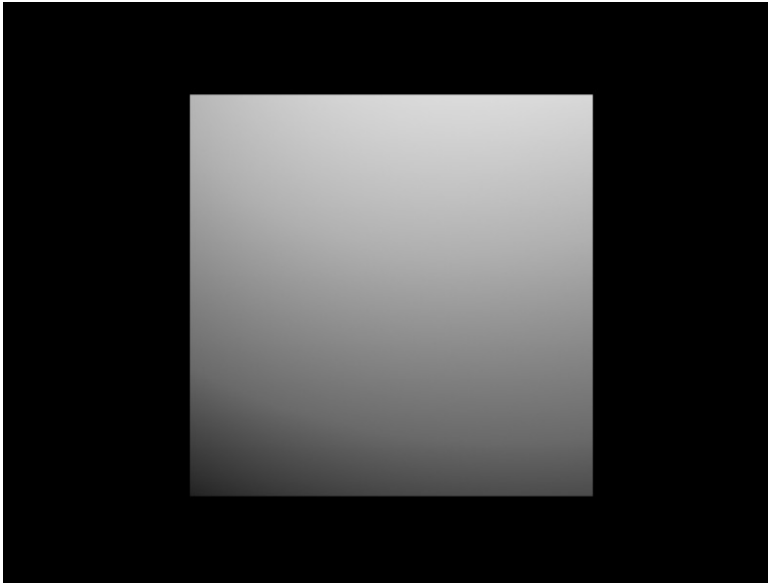
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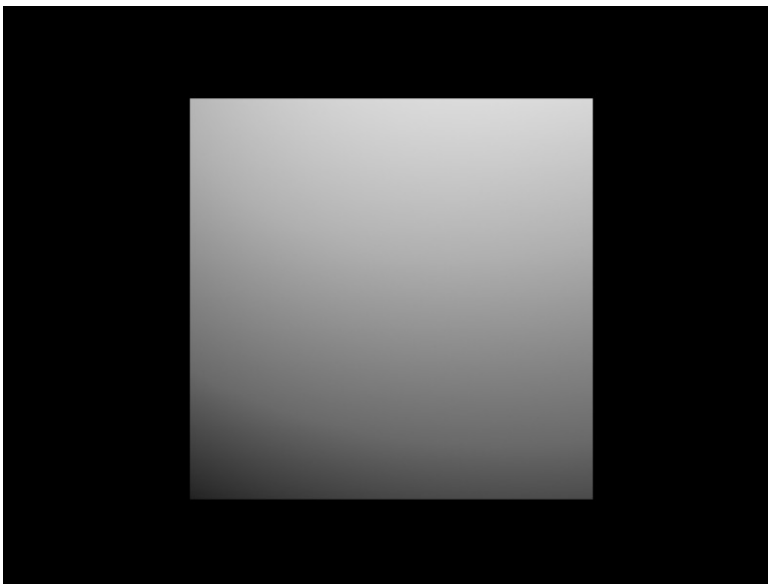
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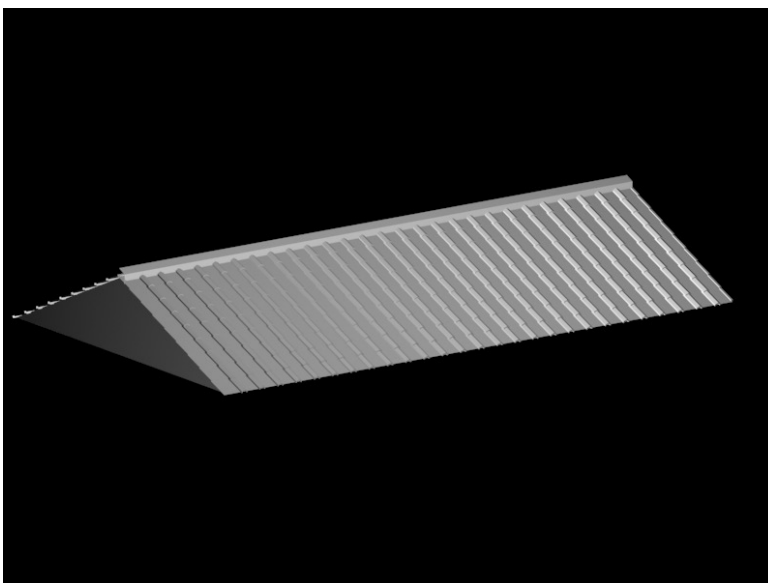
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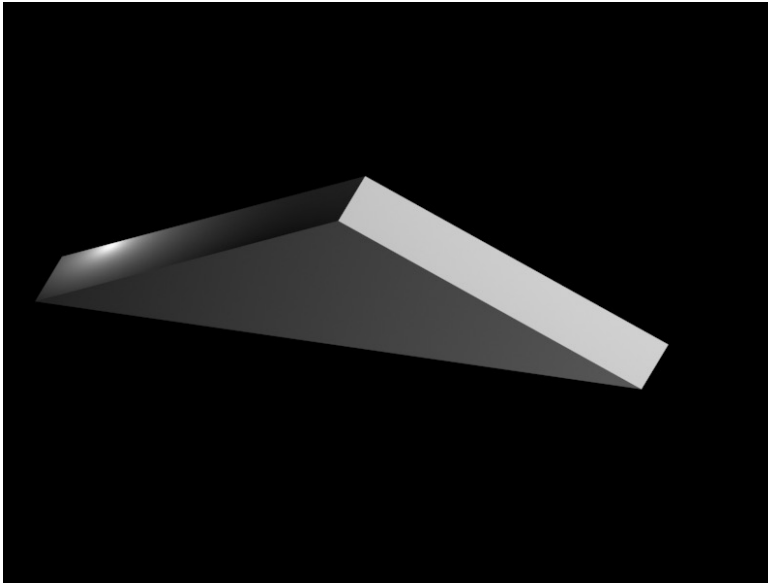
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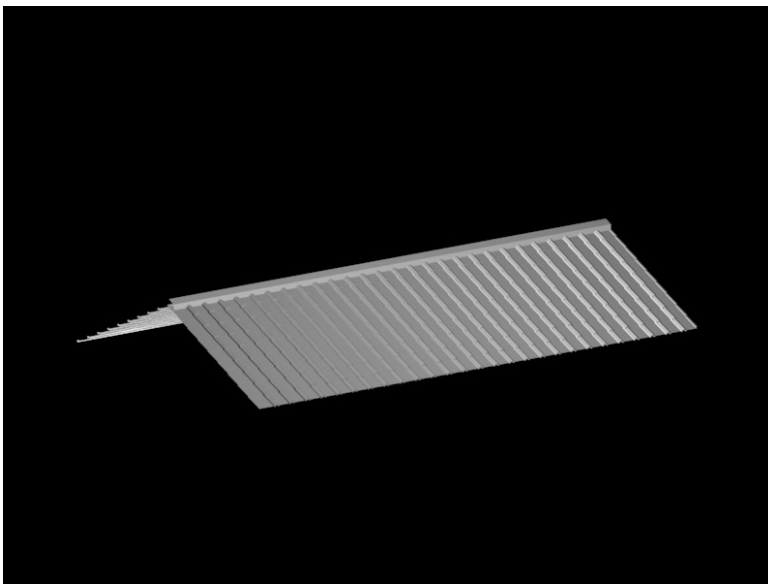
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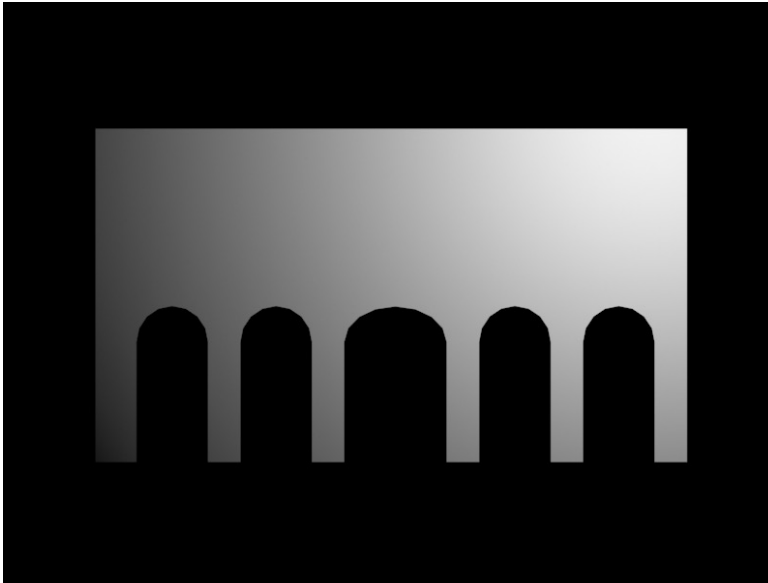
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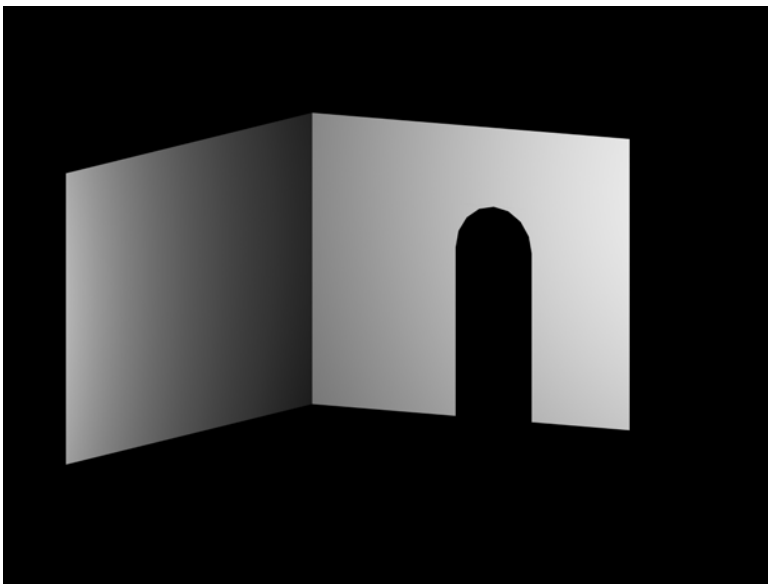
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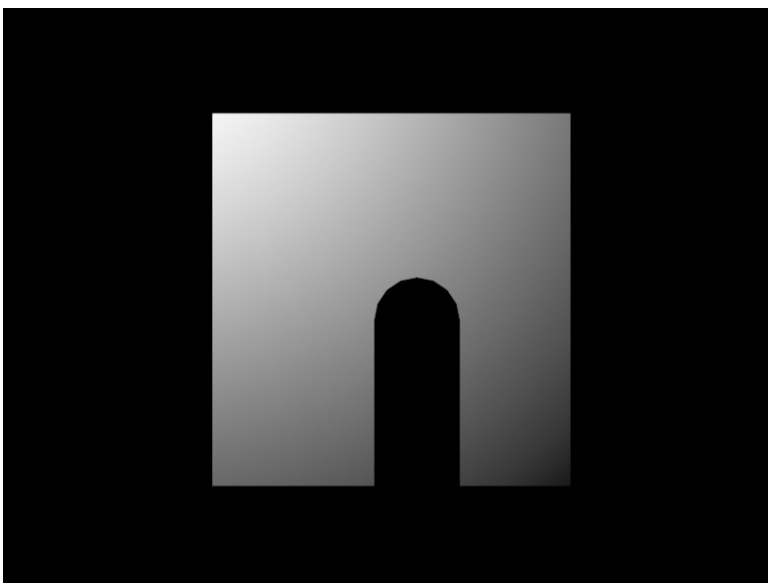
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SpE_CoE_79



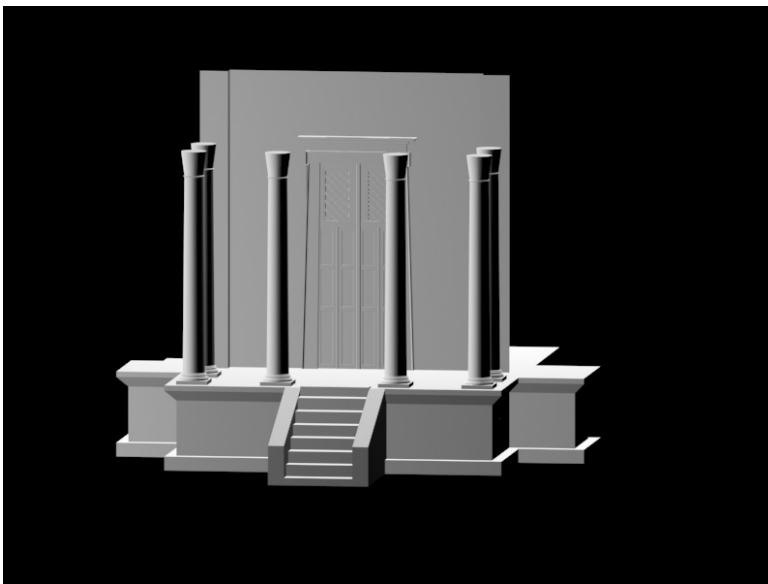
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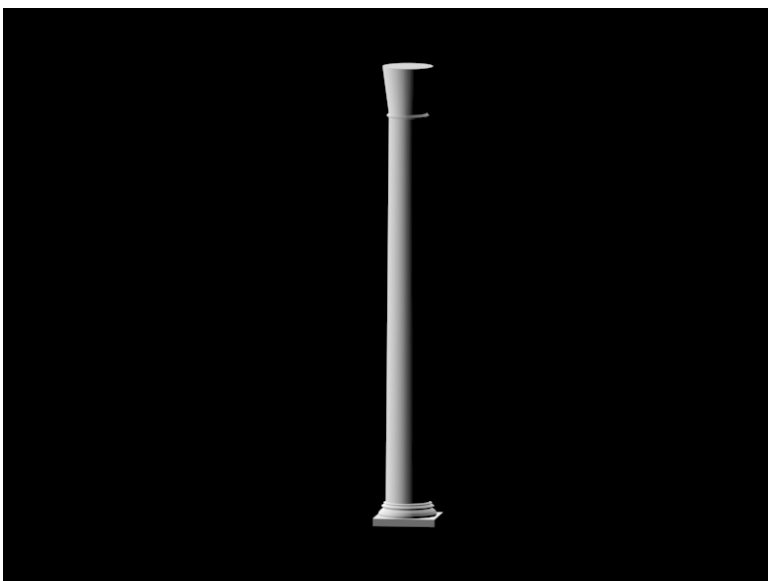
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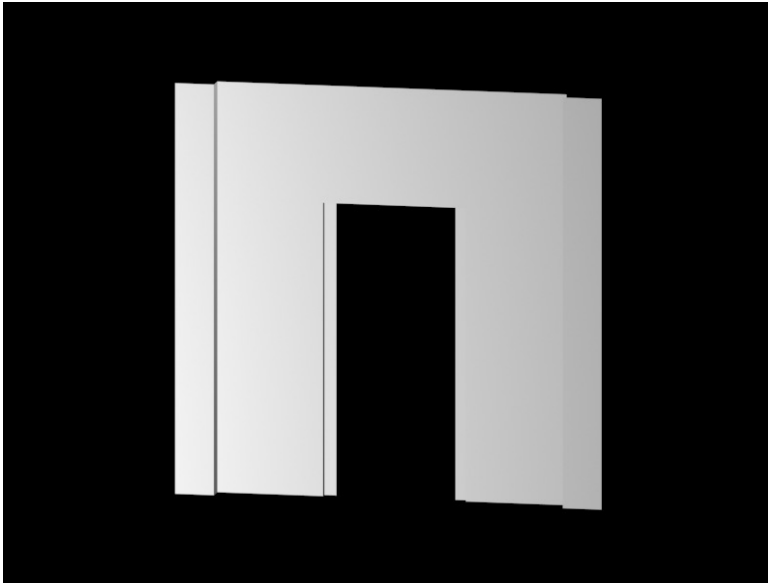
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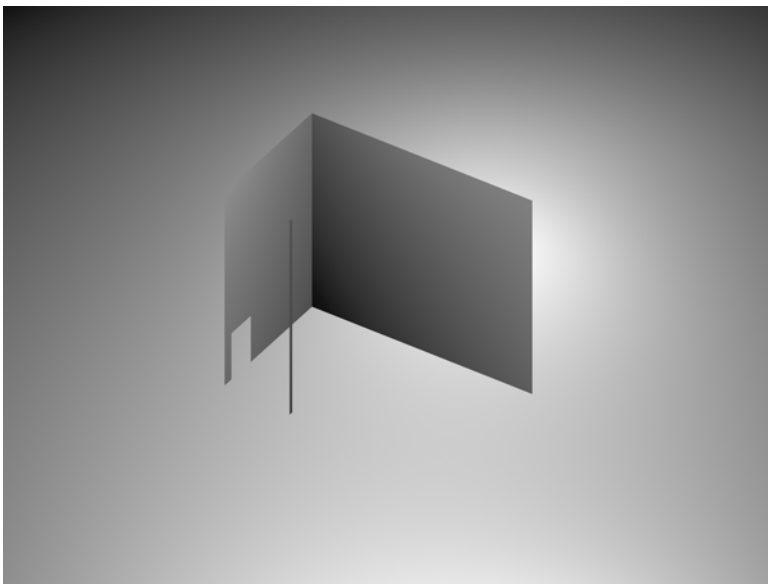
SpaceH_79



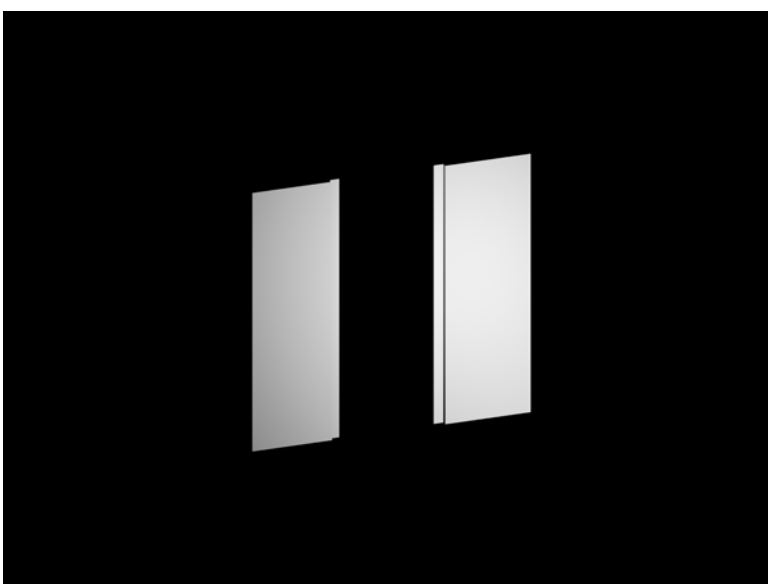
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SpH_CoE_F02_79,
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SpH_CoN_F01_79,
SpH_CoN_F02_79



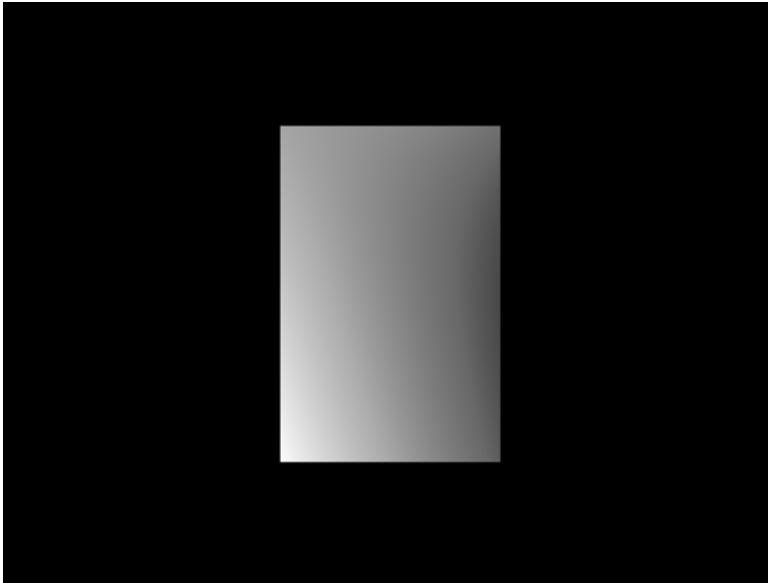
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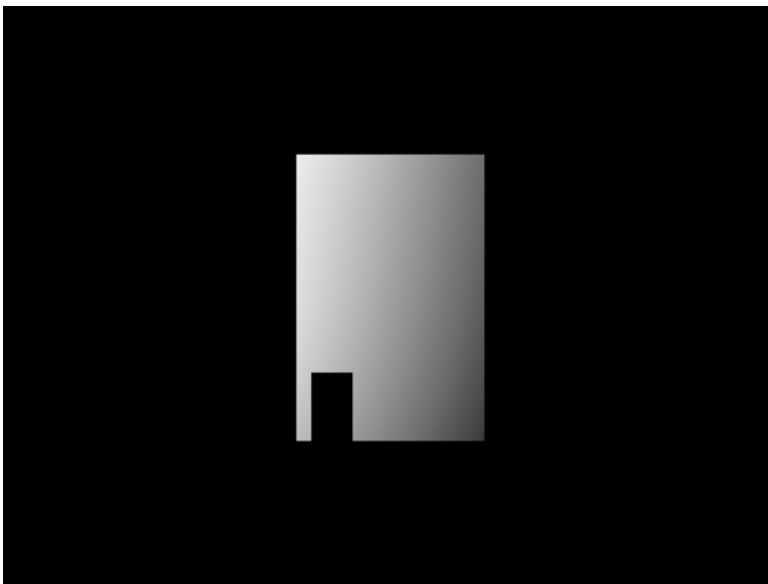
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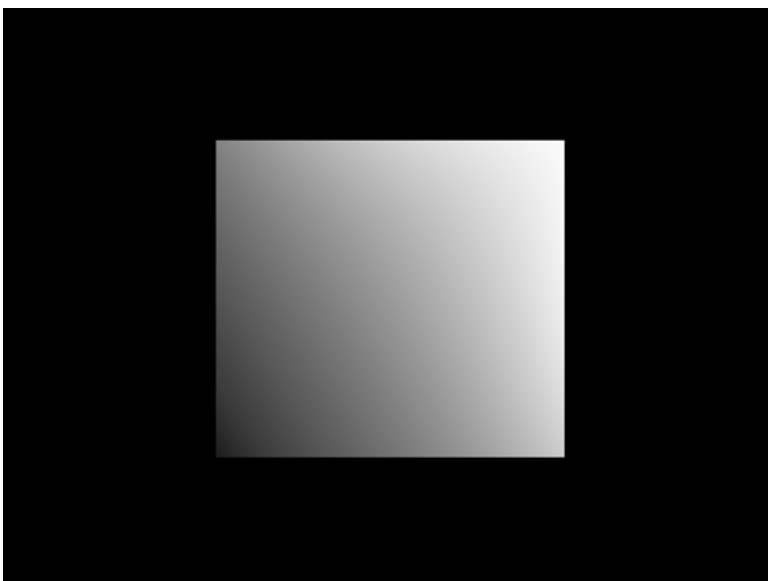
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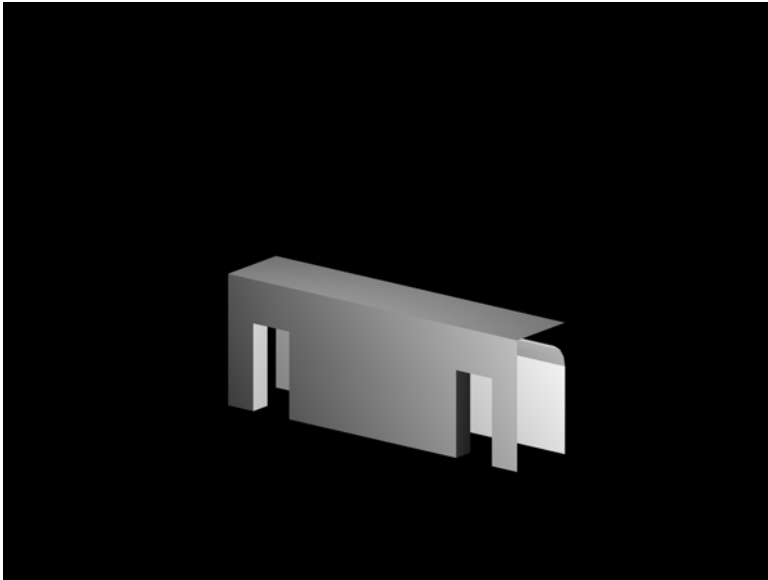
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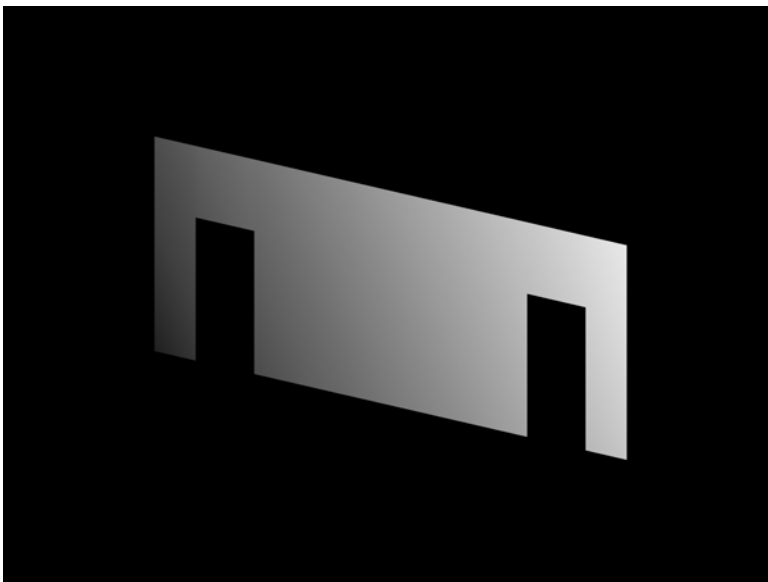
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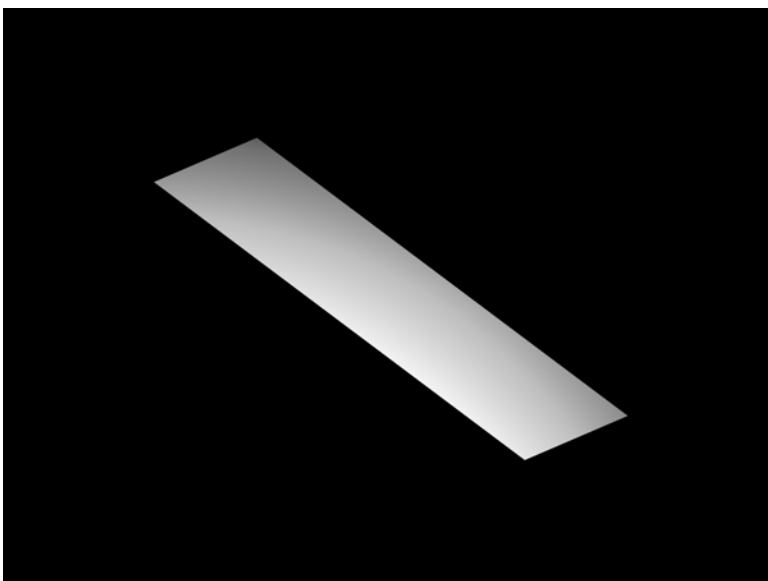
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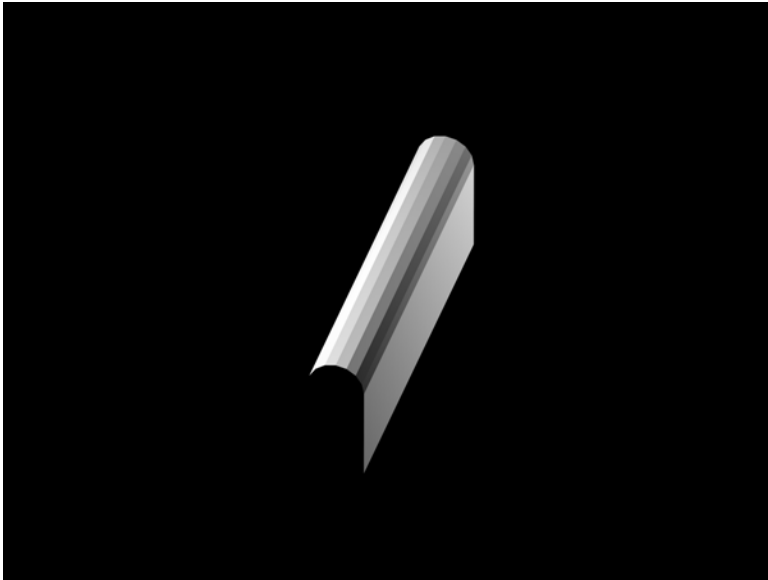
SpaceJ_79



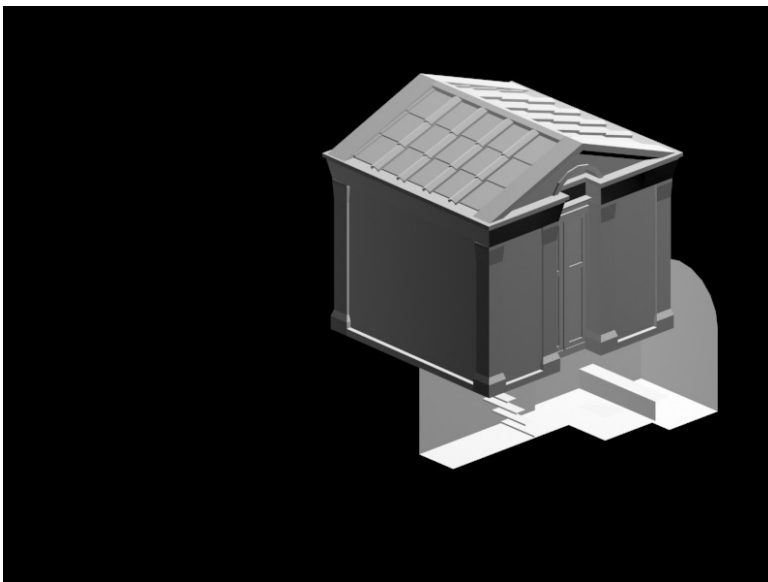
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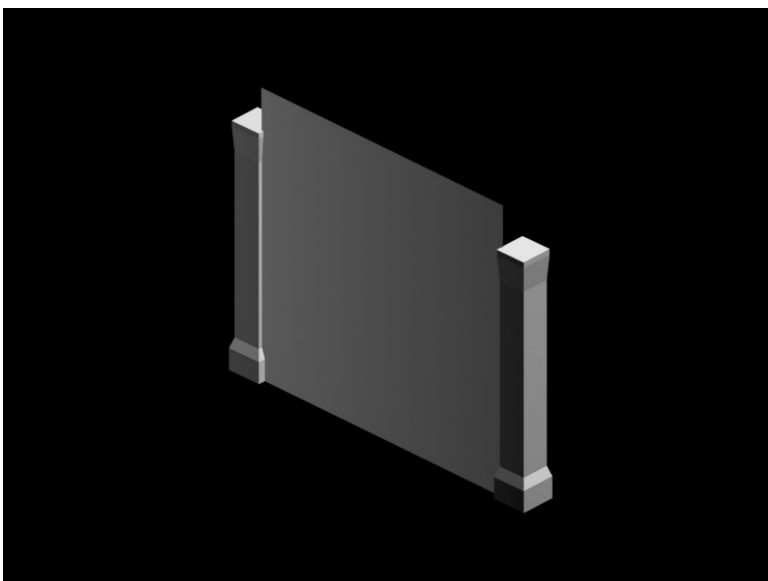
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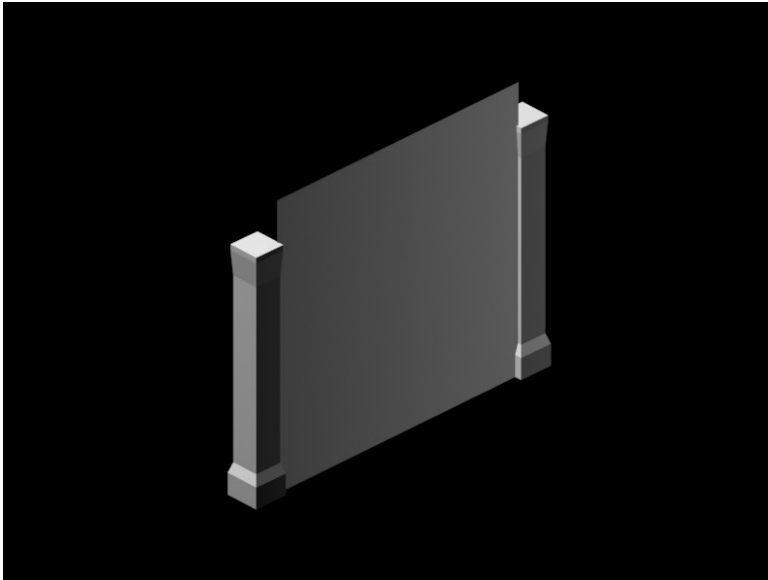
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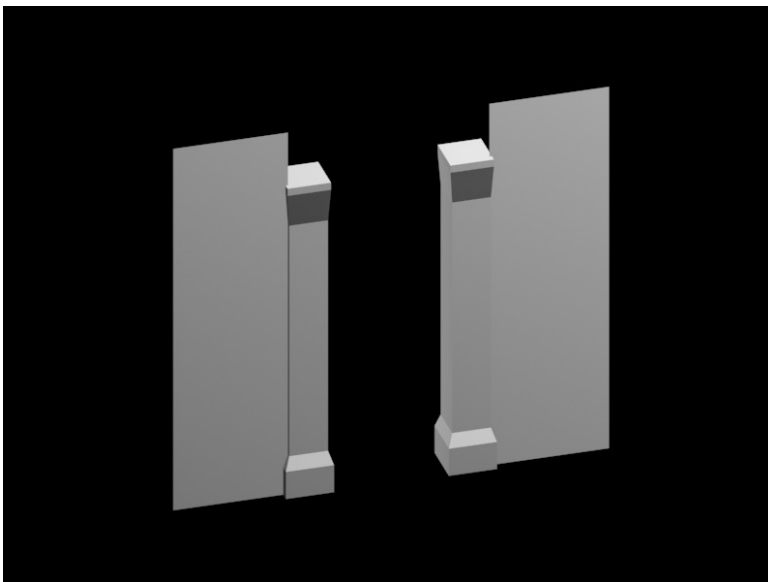
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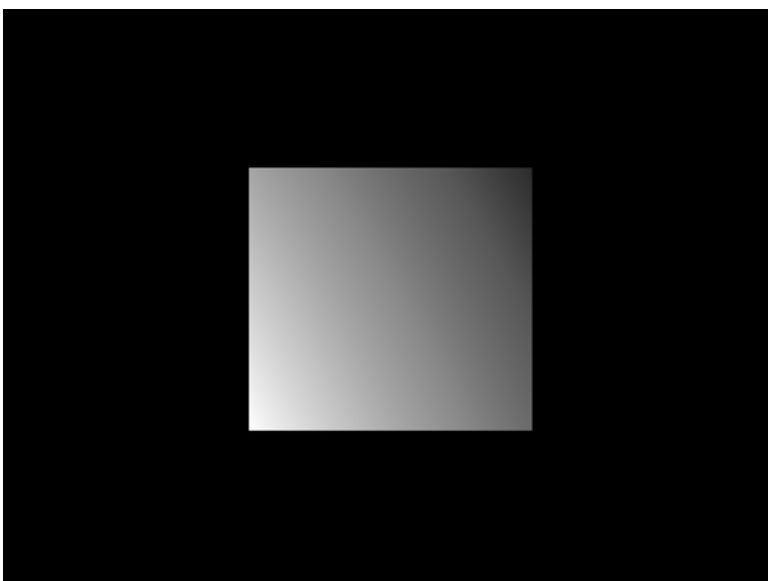
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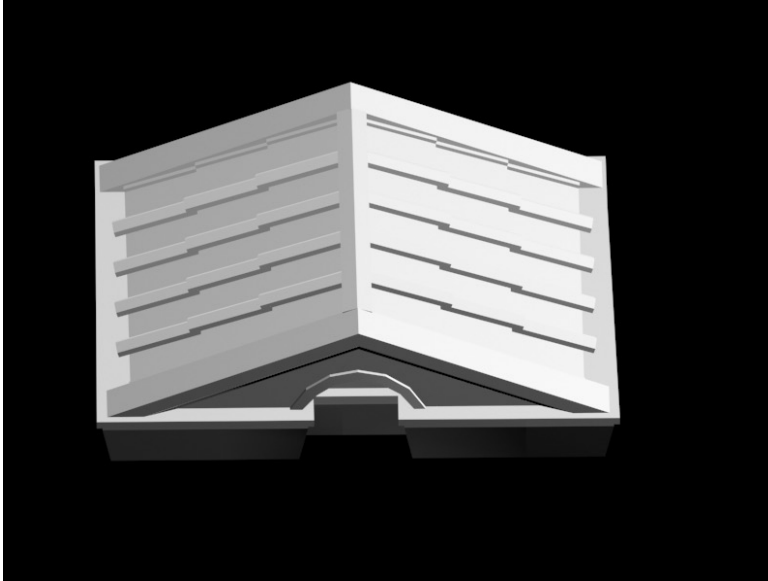
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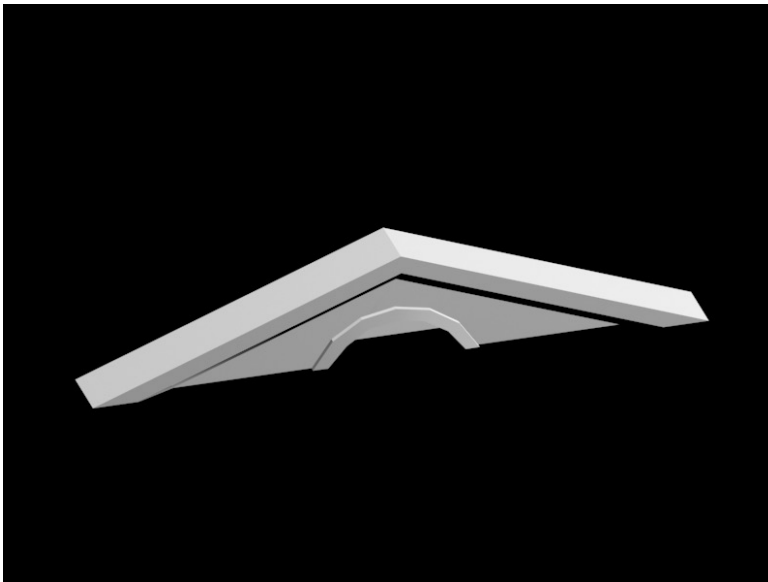
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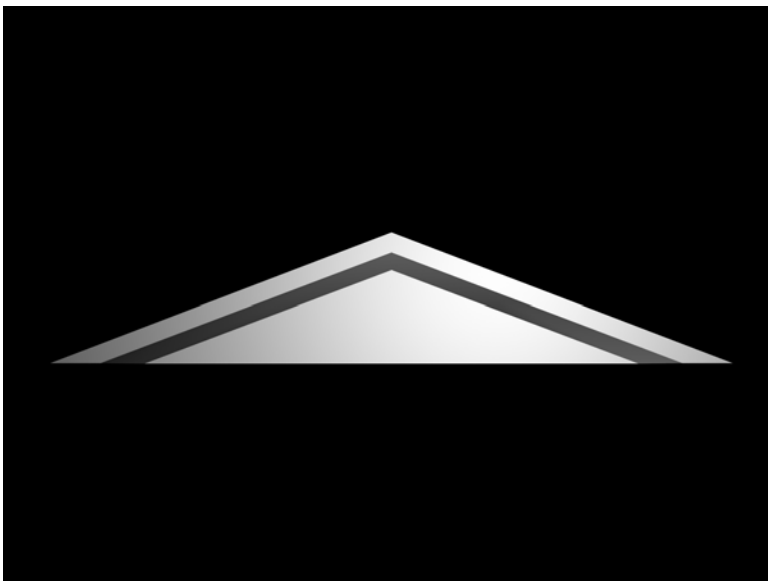
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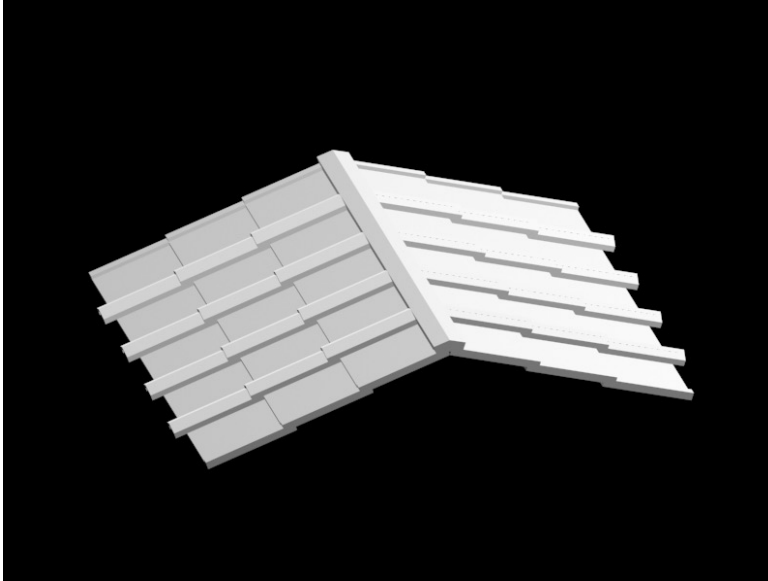
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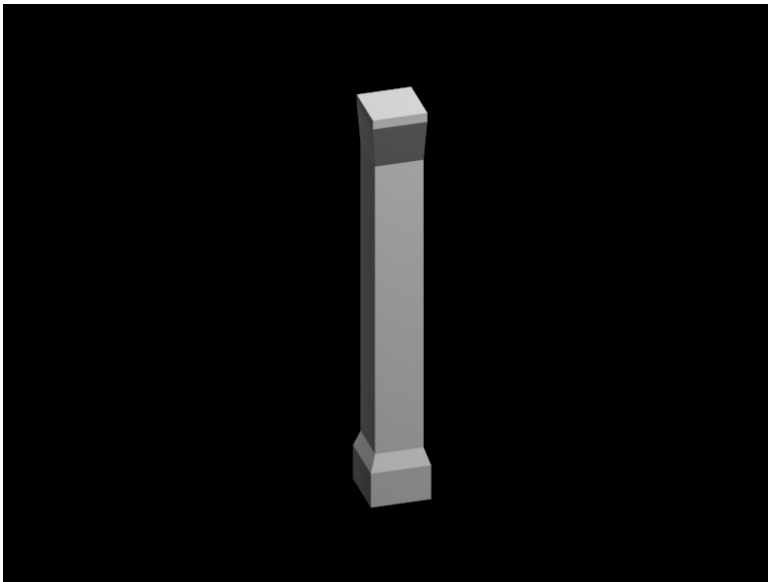
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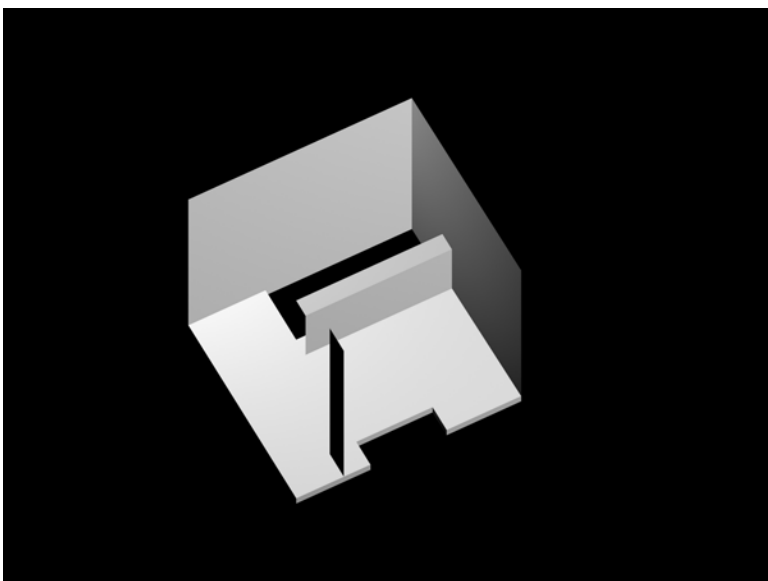
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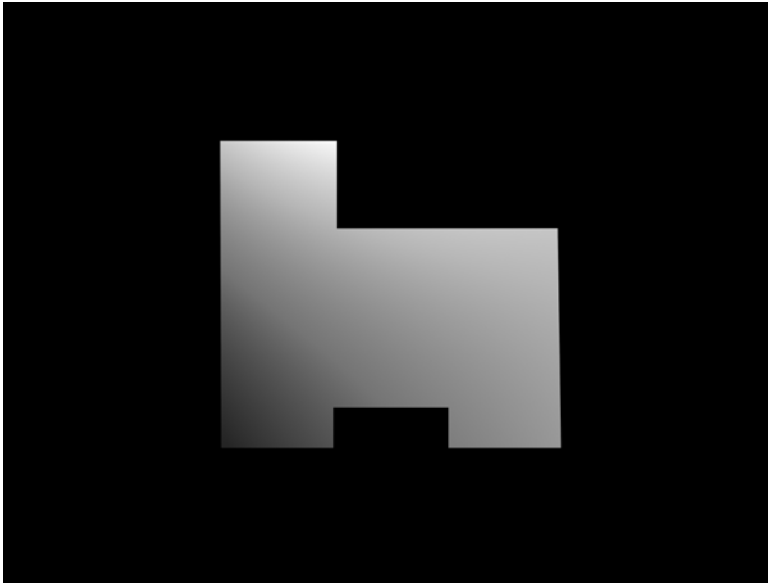
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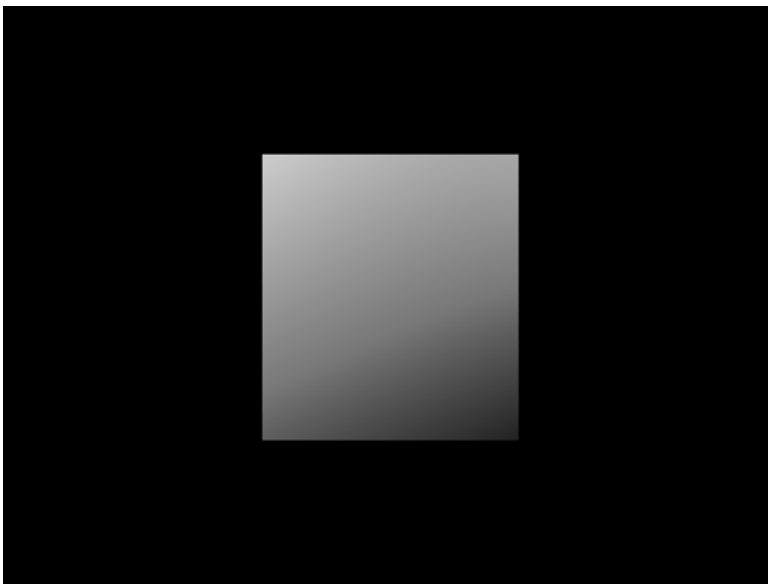
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SpT_F06_79



SpaceM_79



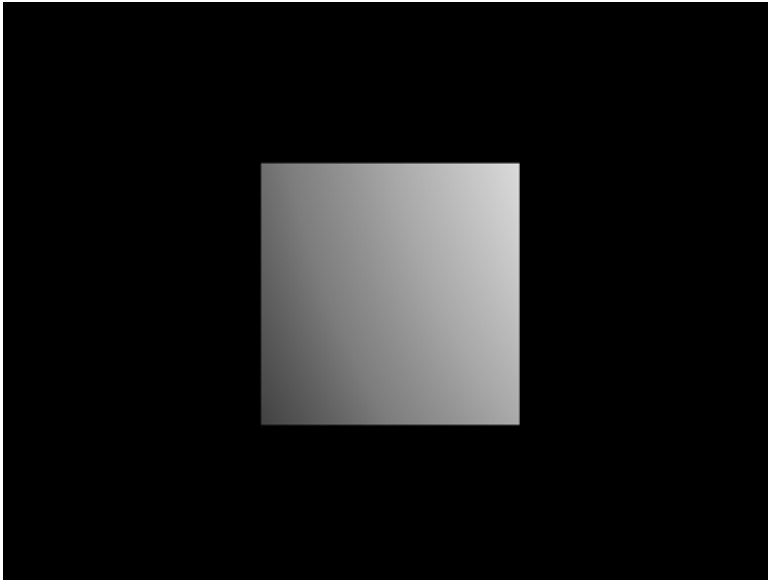
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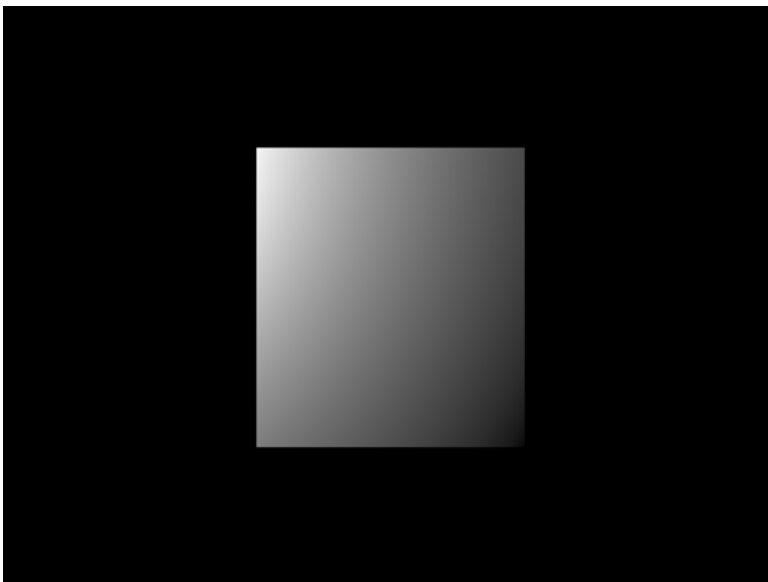
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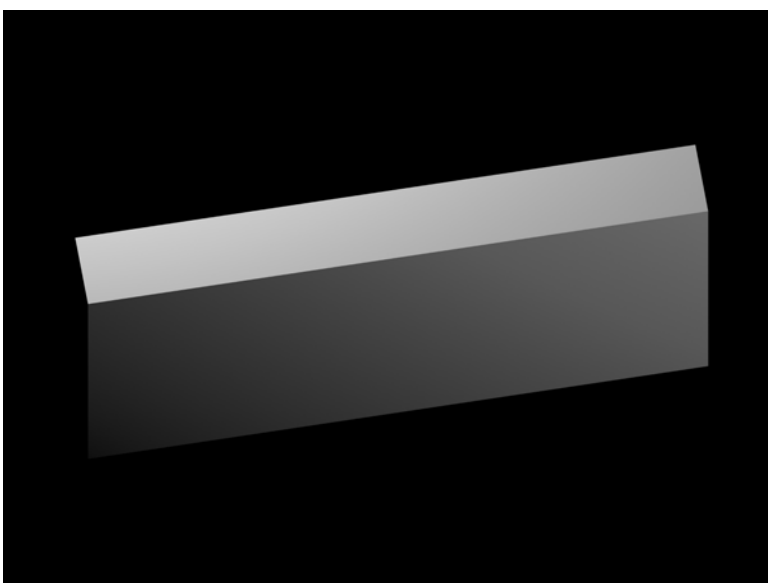
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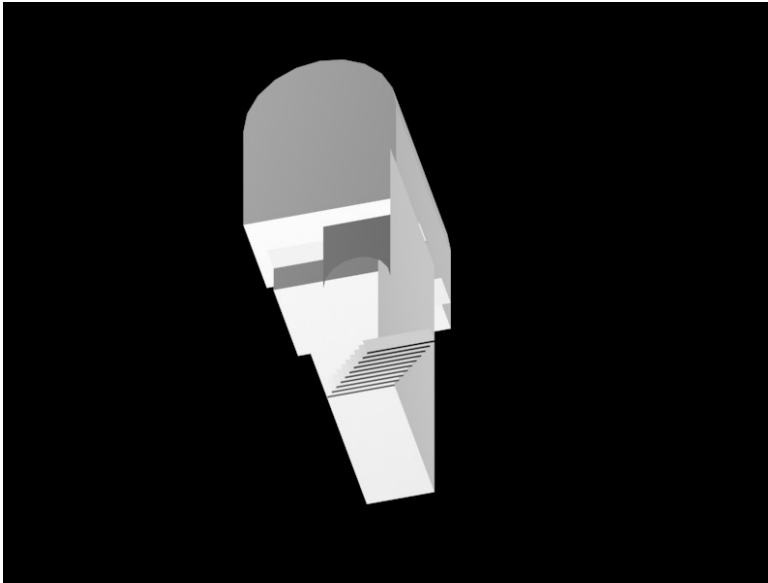
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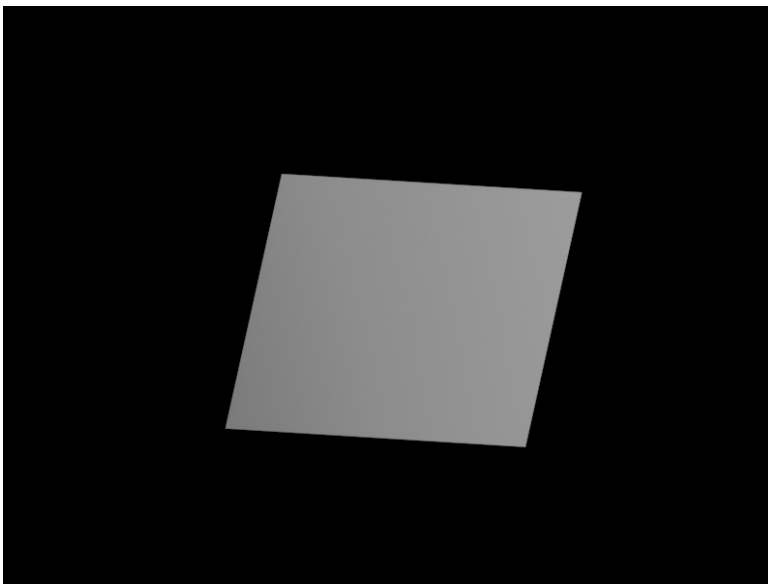
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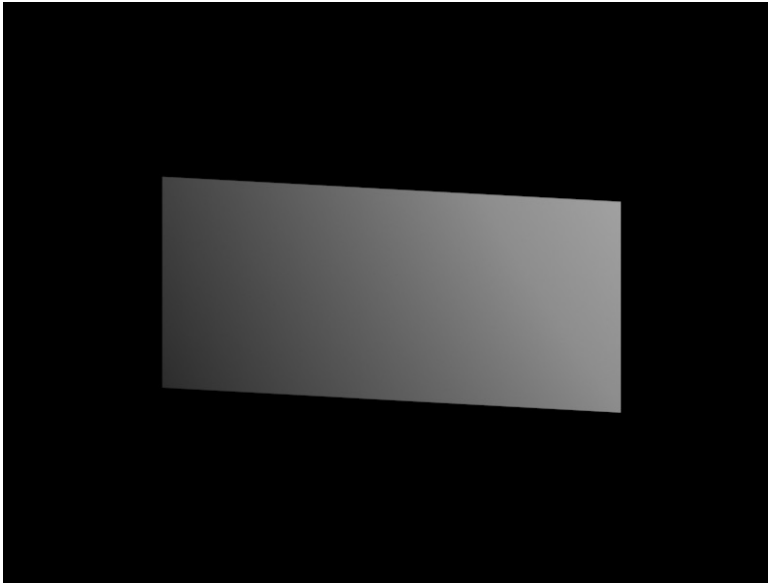
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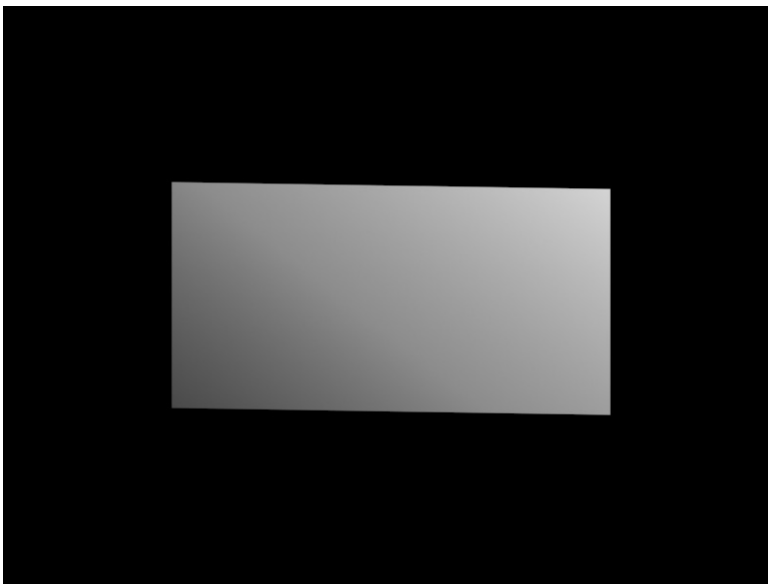
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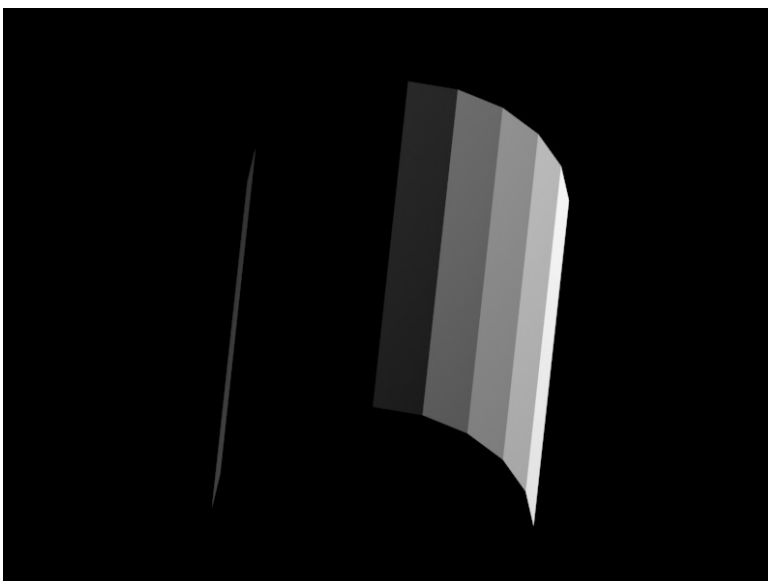
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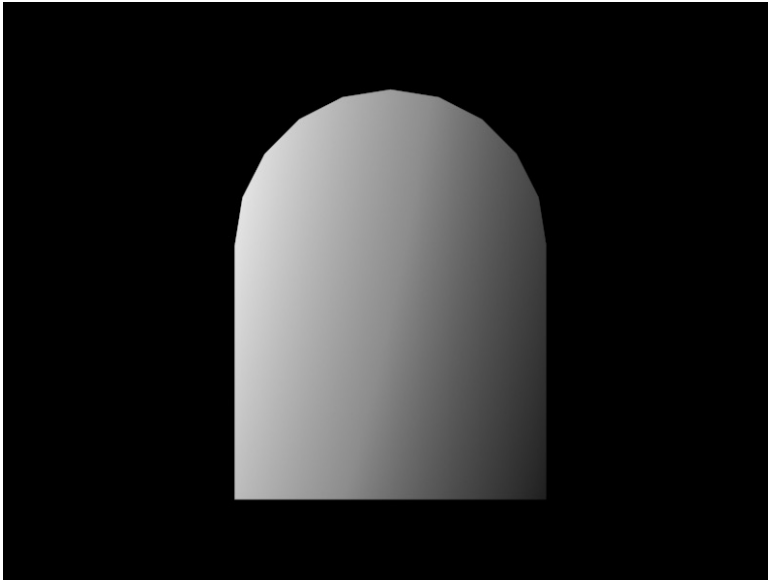
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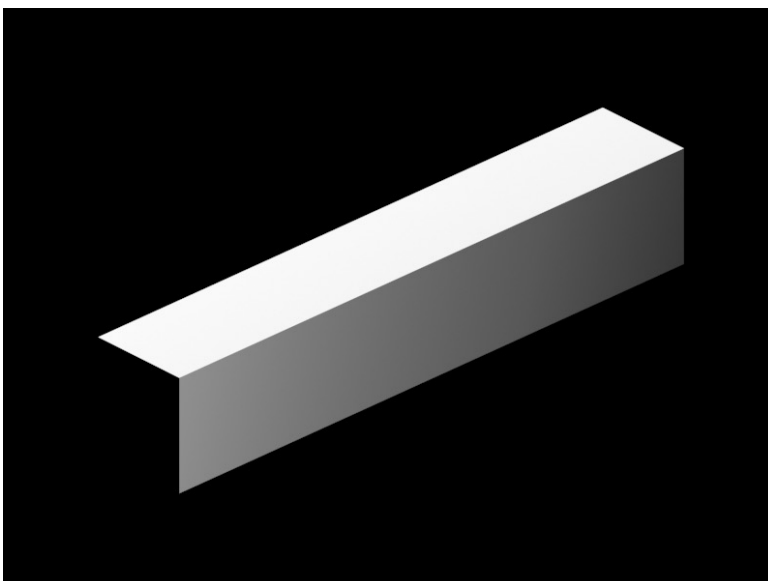
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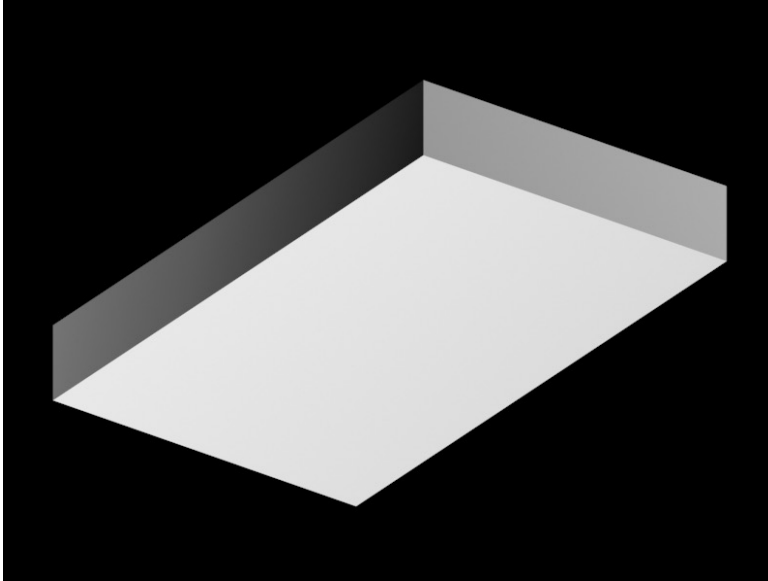
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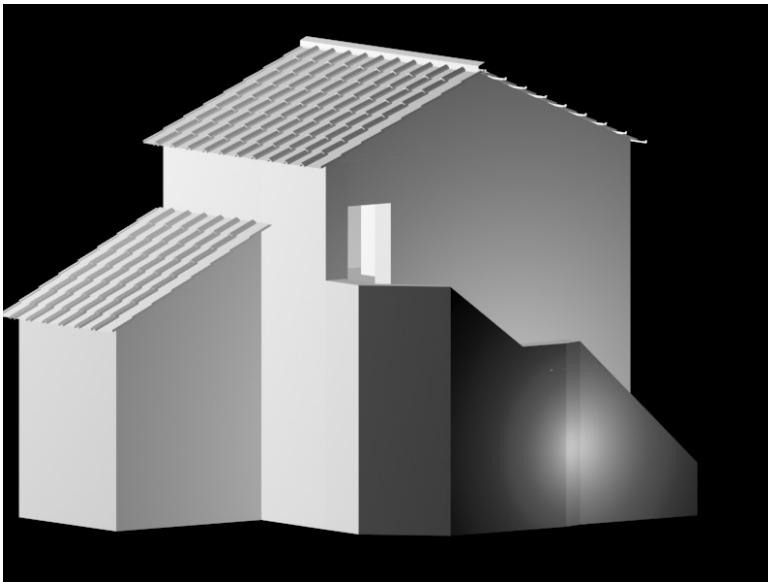
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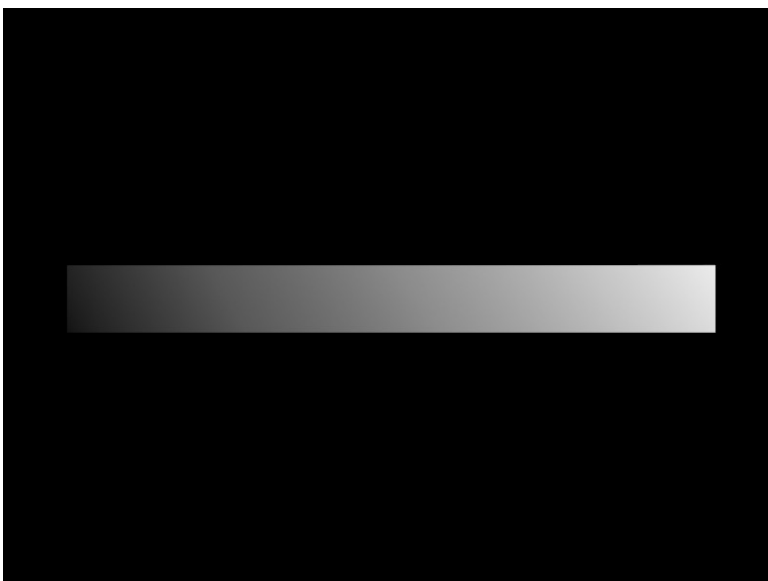
SpU_F02_79



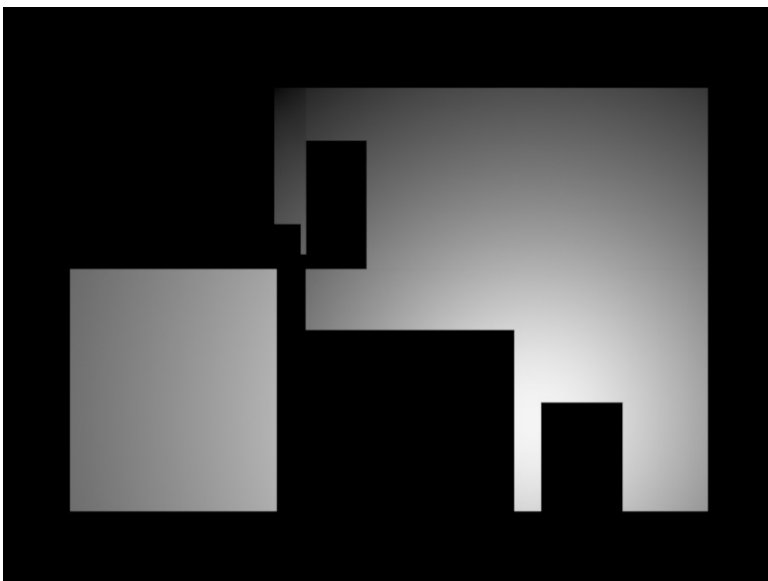
SpU_F03_79



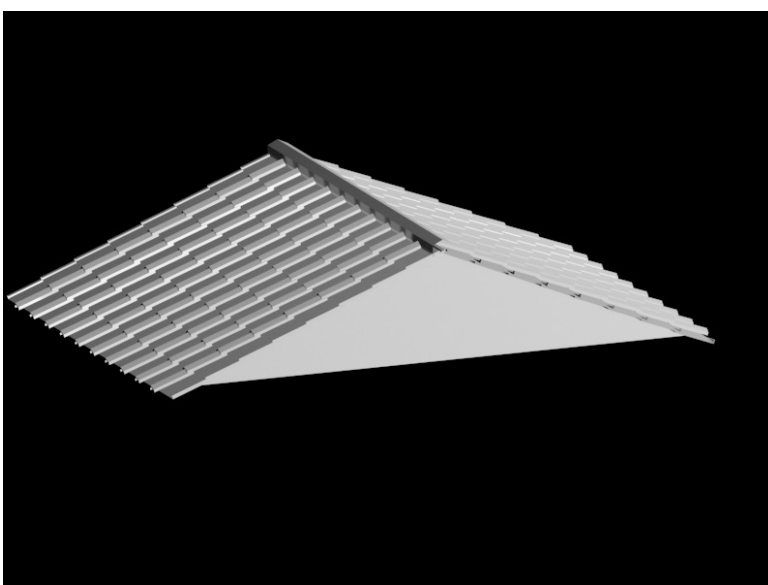
SpaceO_79



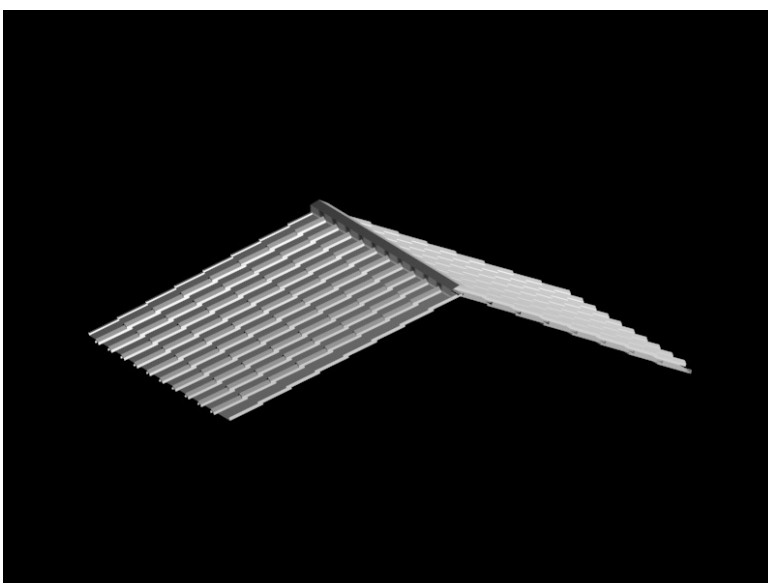
SpO_CoN_79



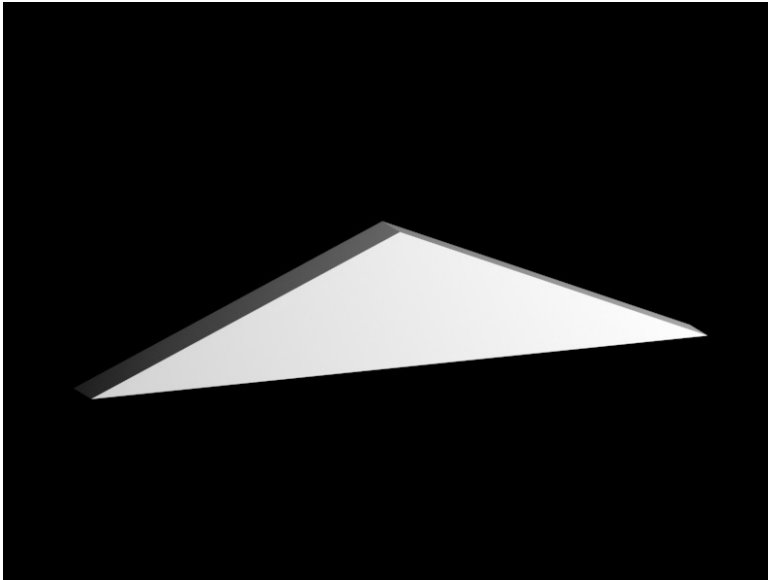
SpO_CoS_79



SpO_CoU_79



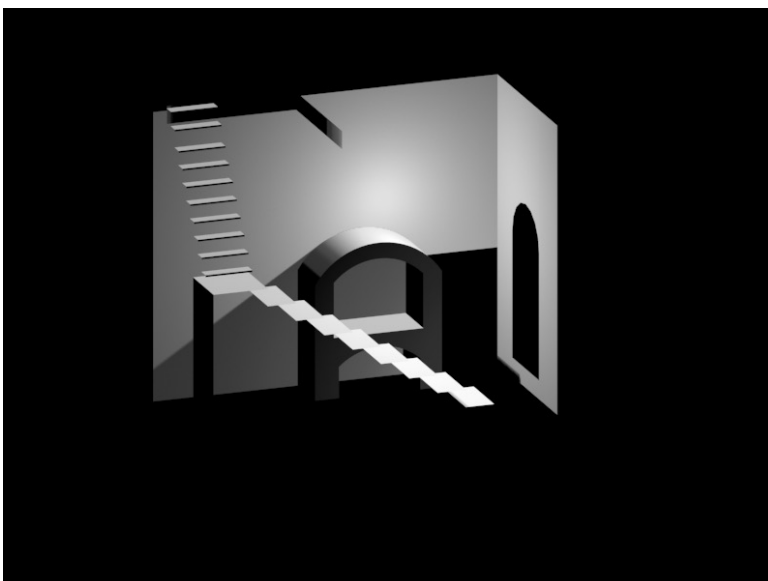
SpO_CoU_F01_79



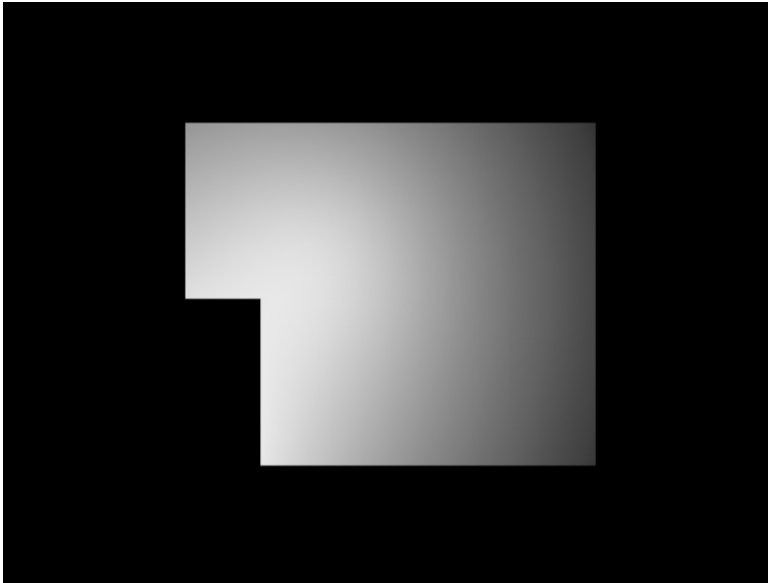
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SpO_CoU_F03_79



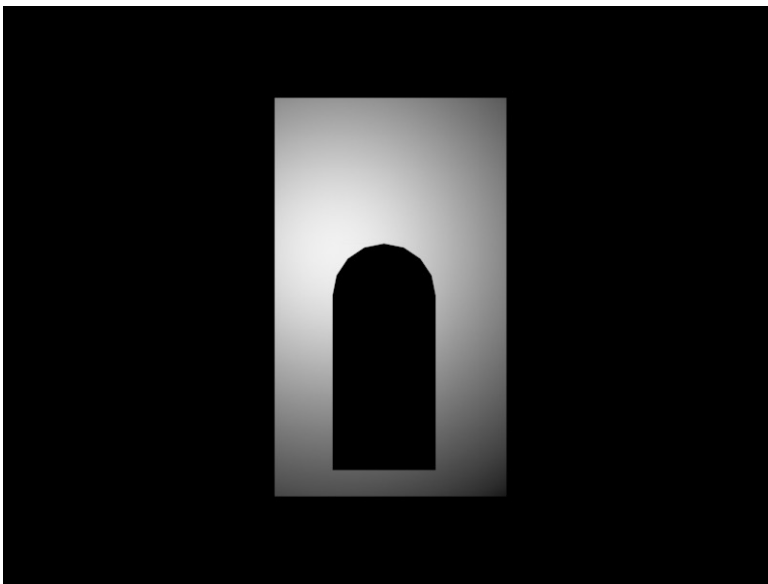
SpO_CoW_79



SpaceG_79



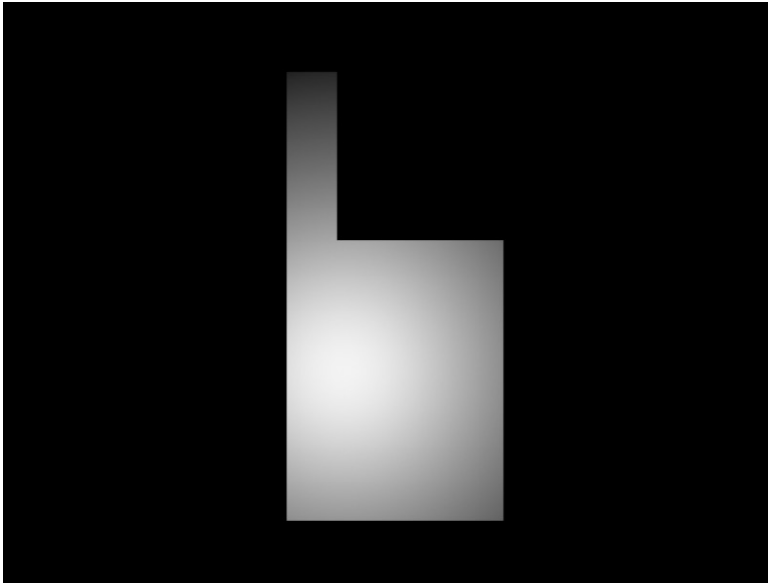
SpG_CoE_79



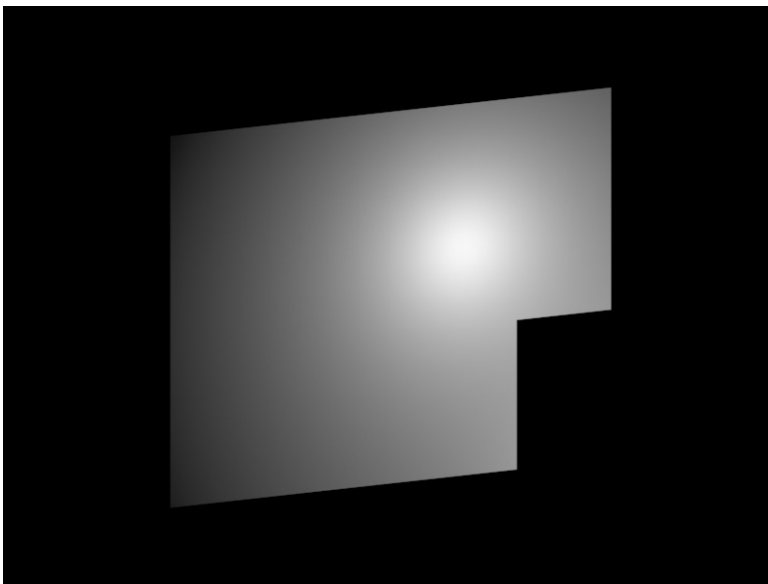
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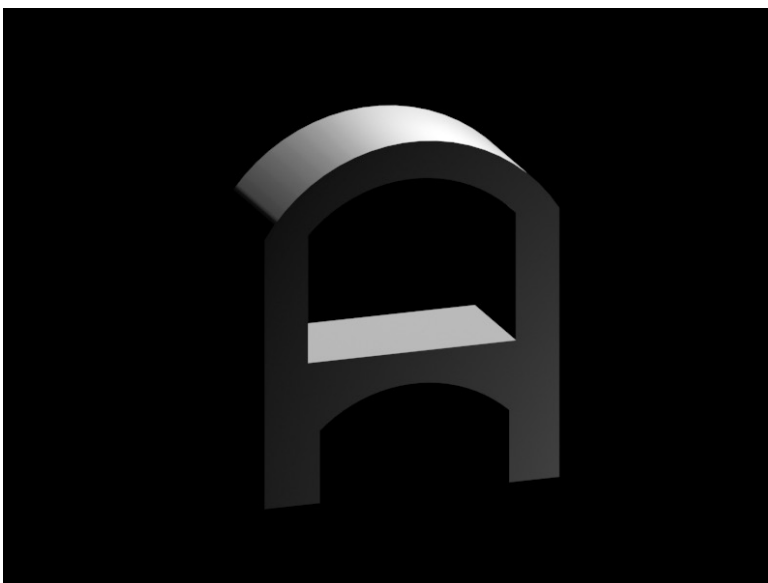
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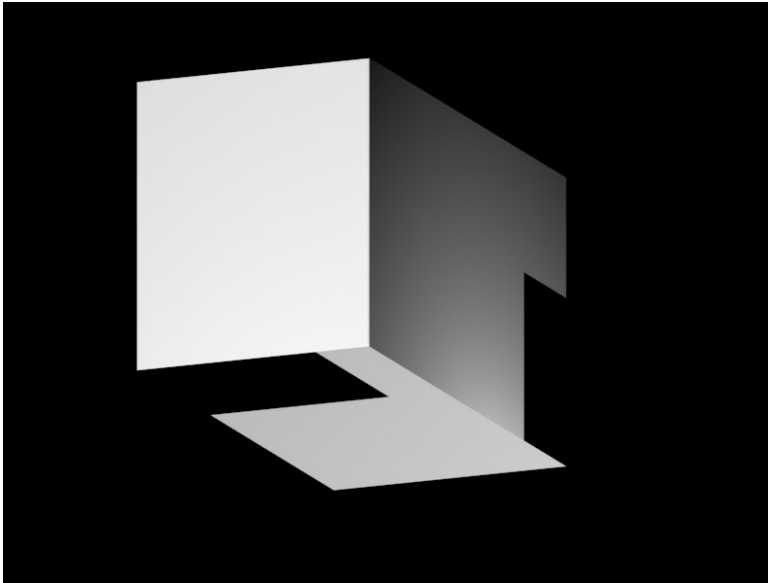
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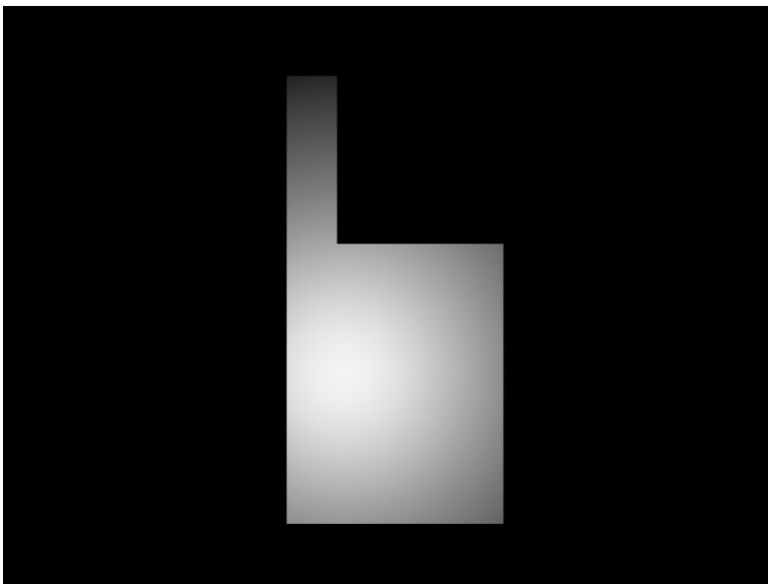
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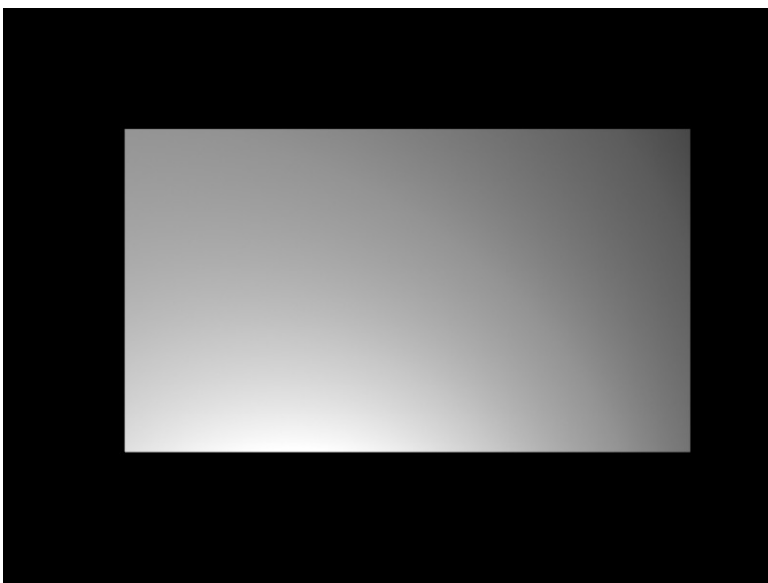
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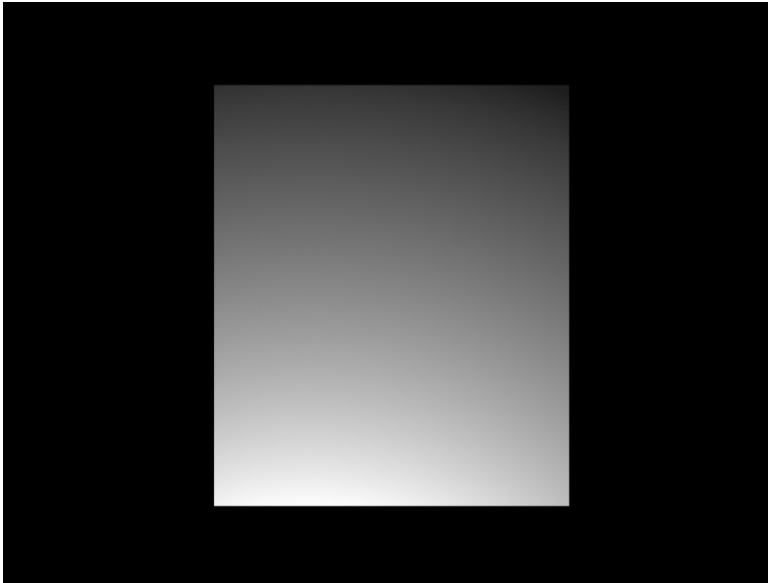
SpaceP_79



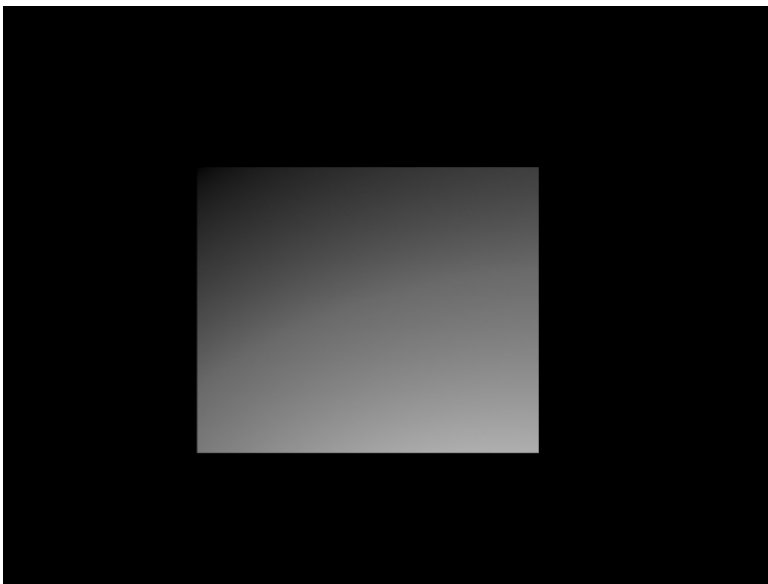
SpP_CoD_79



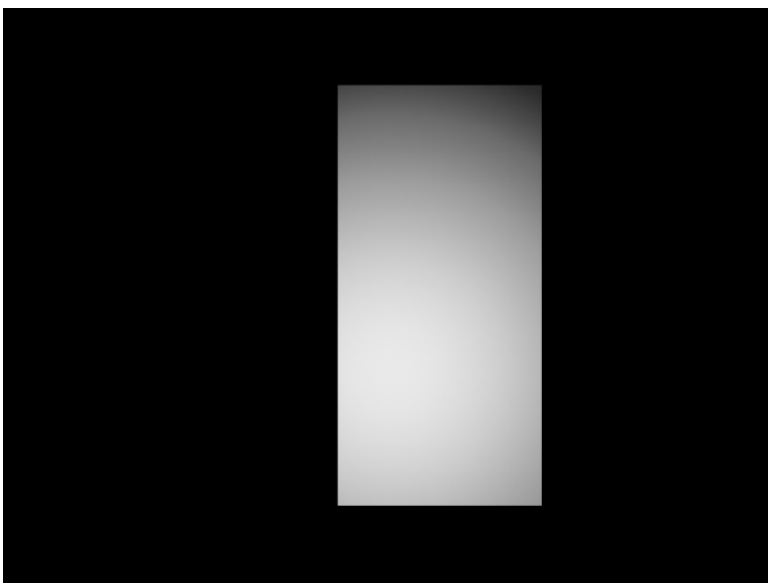
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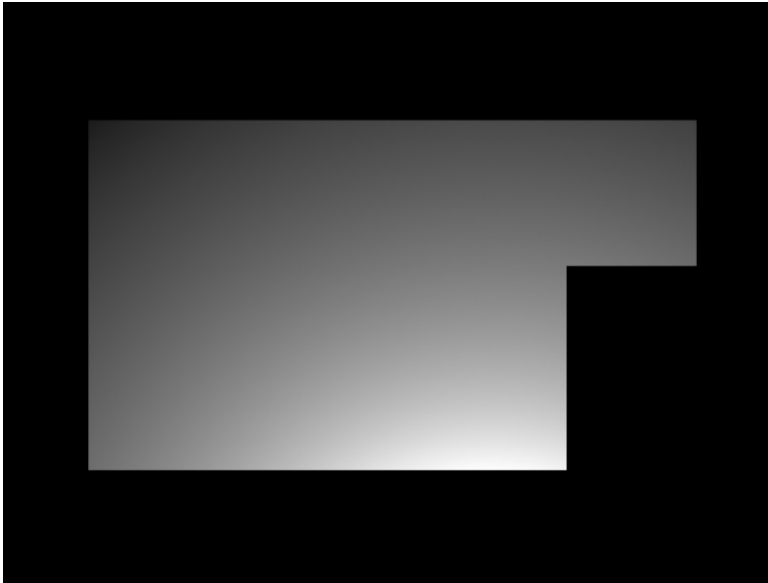
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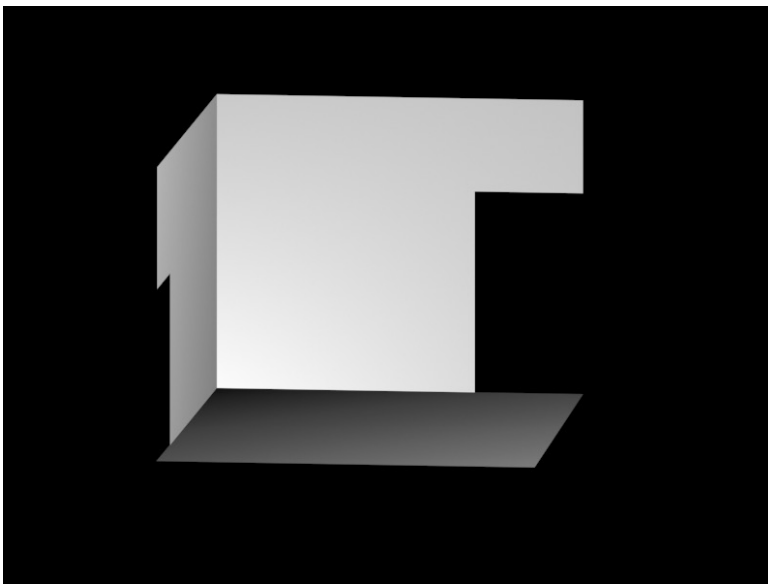
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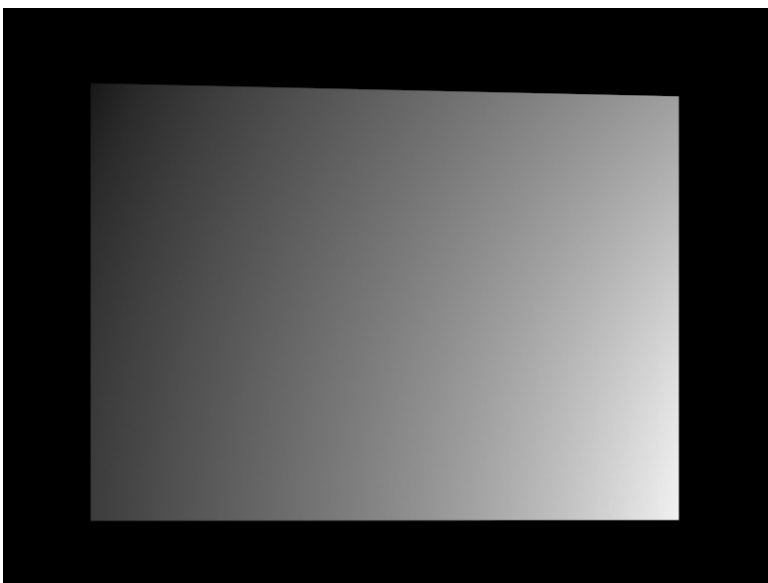
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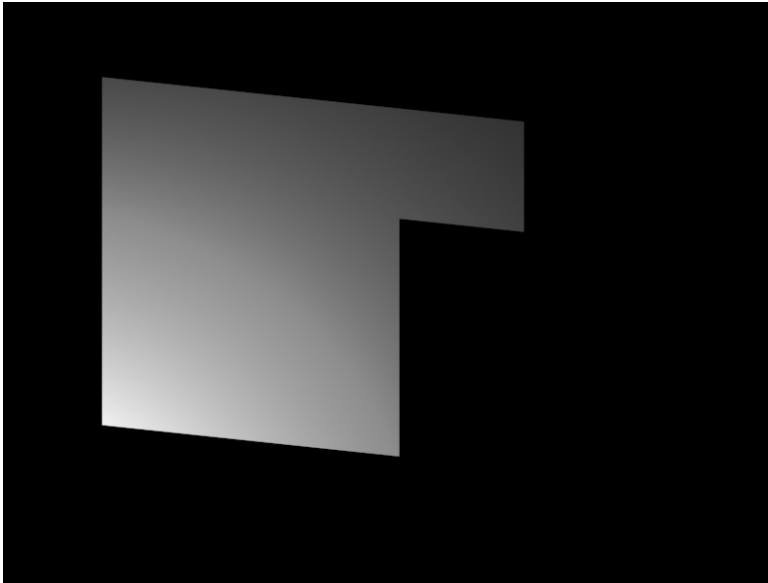
SpP_CoW_79



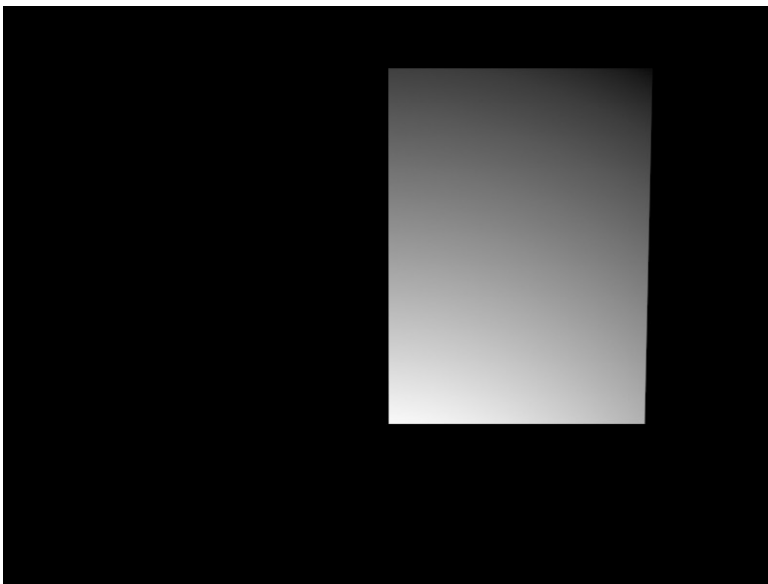
SpaceQ_79



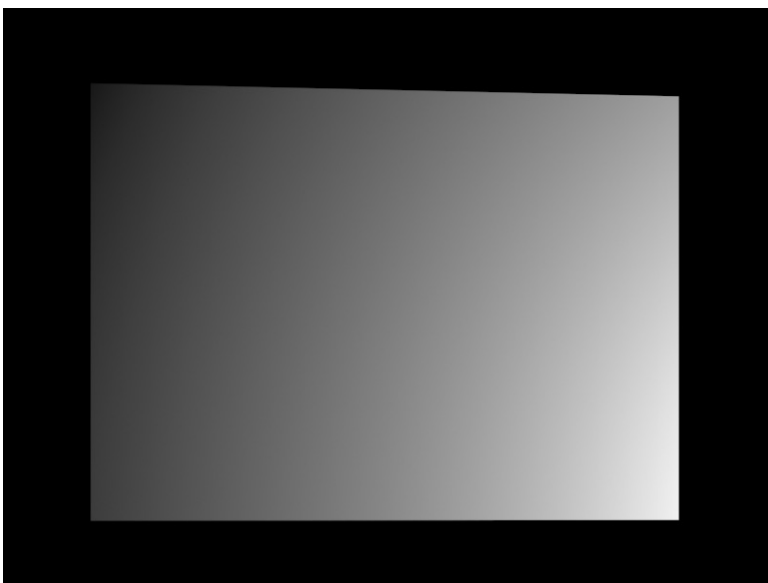
SpQ_CoD_79



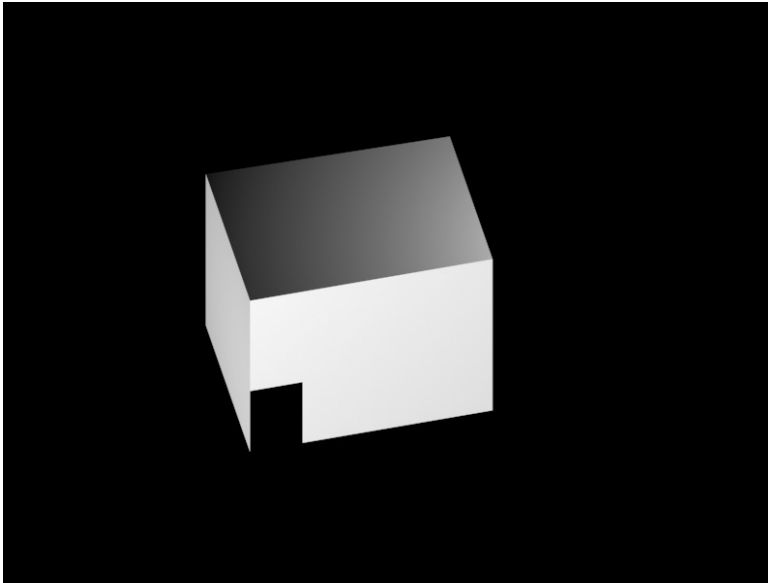
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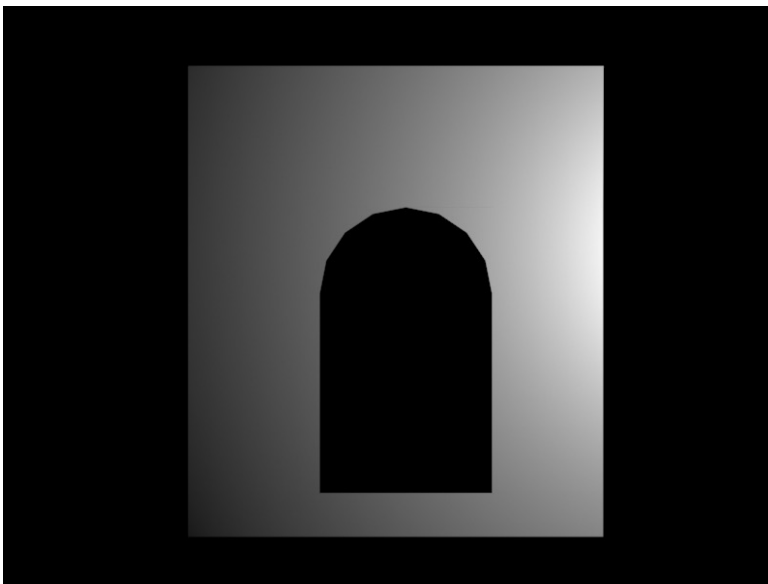
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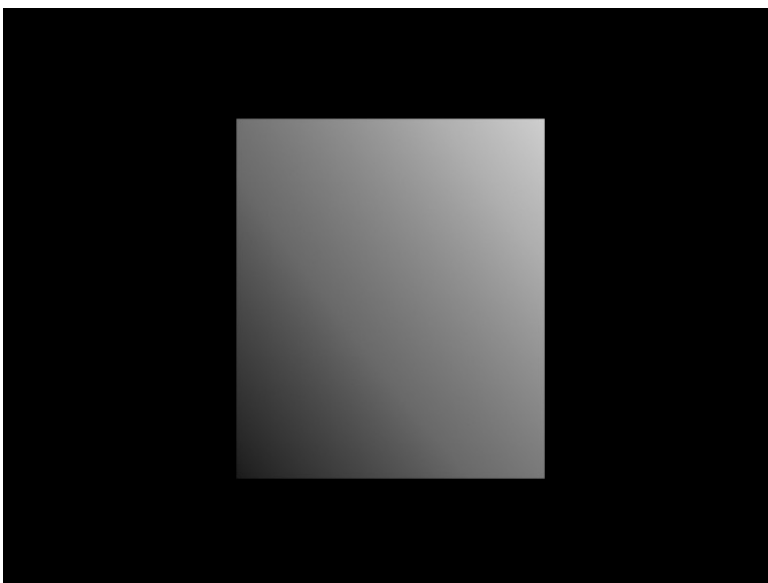
SpQ_CoD_79



SpaceR_79



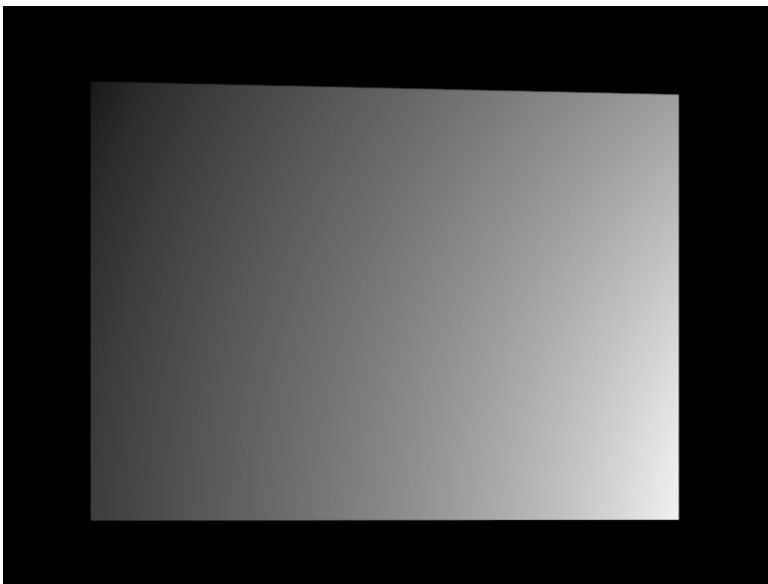
SpR_CoN_79



SpR_CoS_79



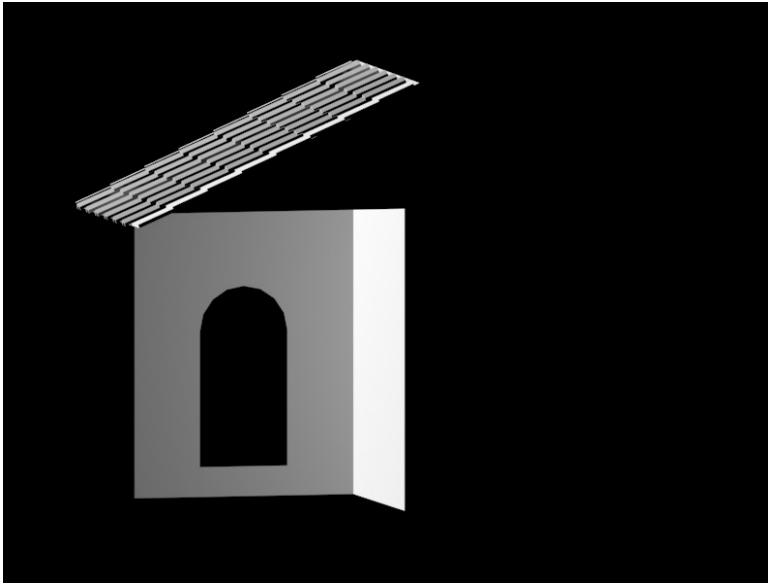
SpR_CoE_79



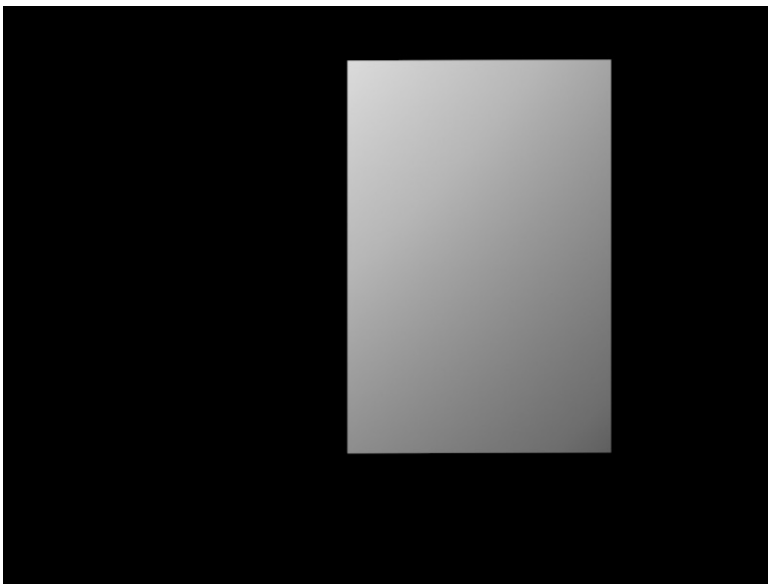
SpR_CoD_79



SpR_CoW_79



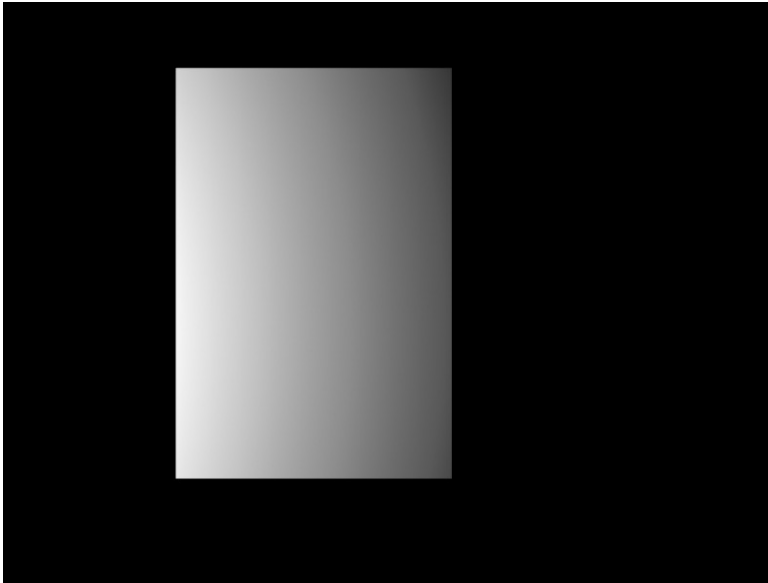
SpaceS_79



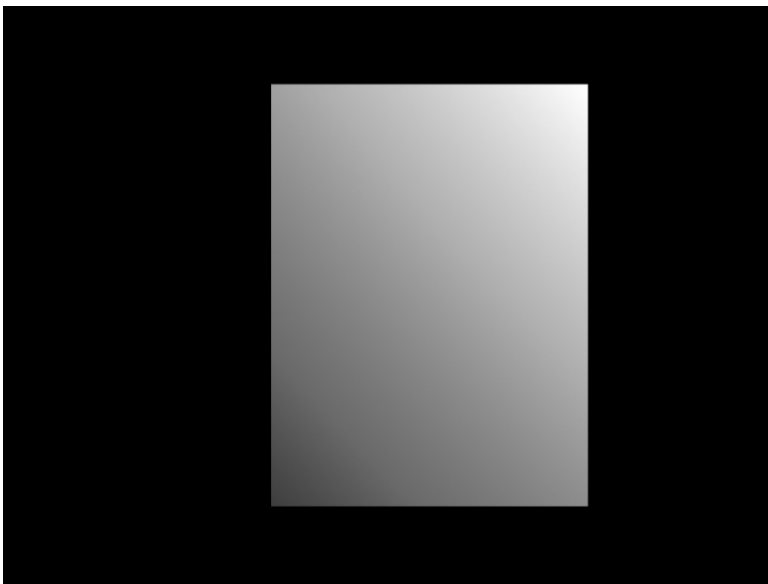
SpS_CoE_79



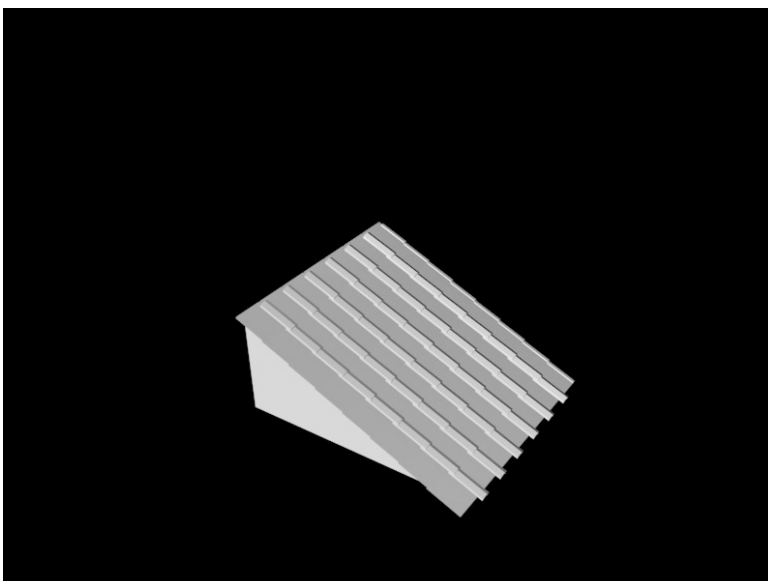
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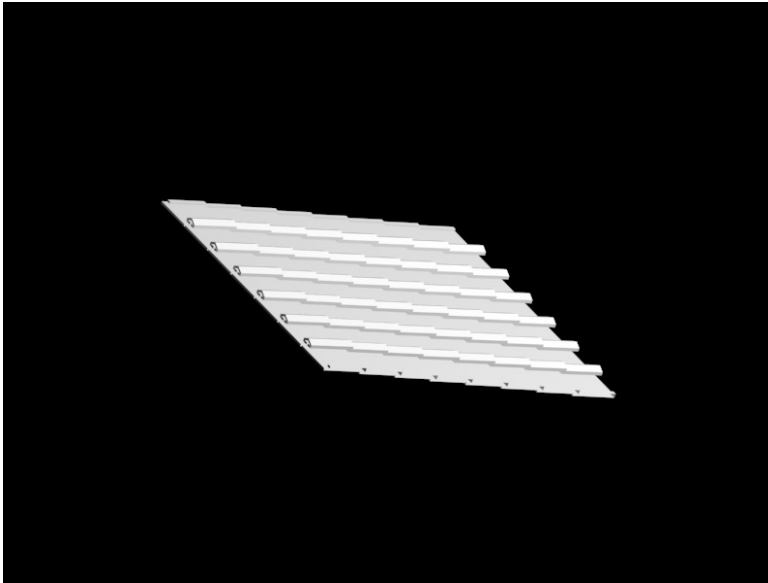
SpS_CoW_79



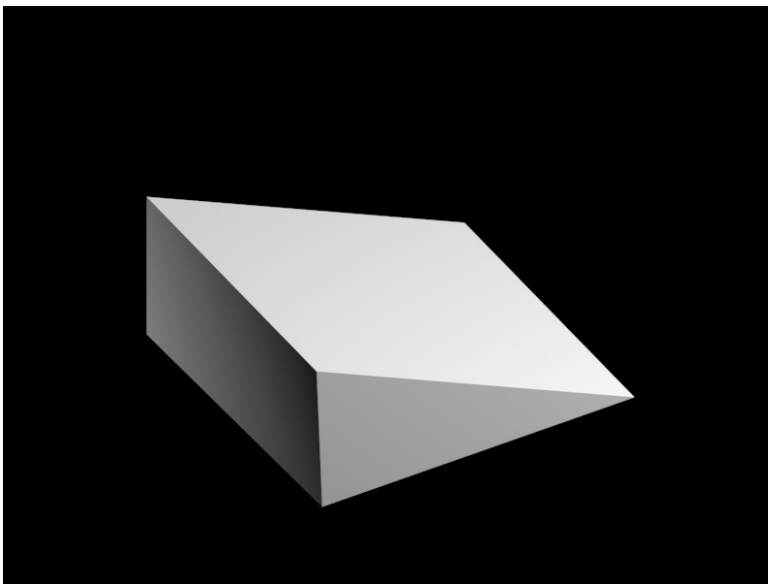
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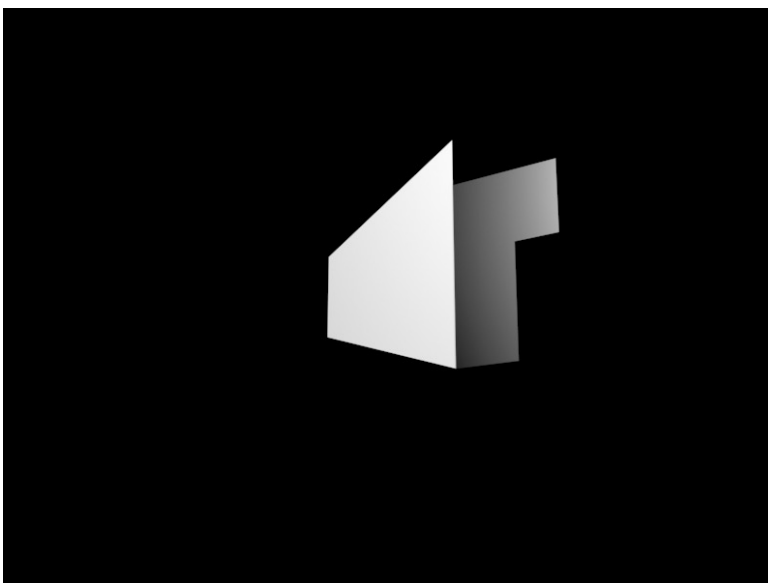
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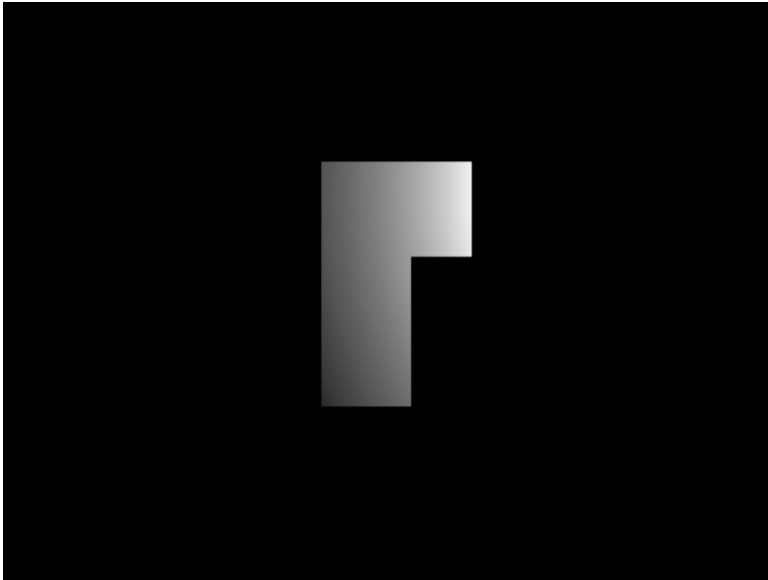
SpS_CoU_F01_79



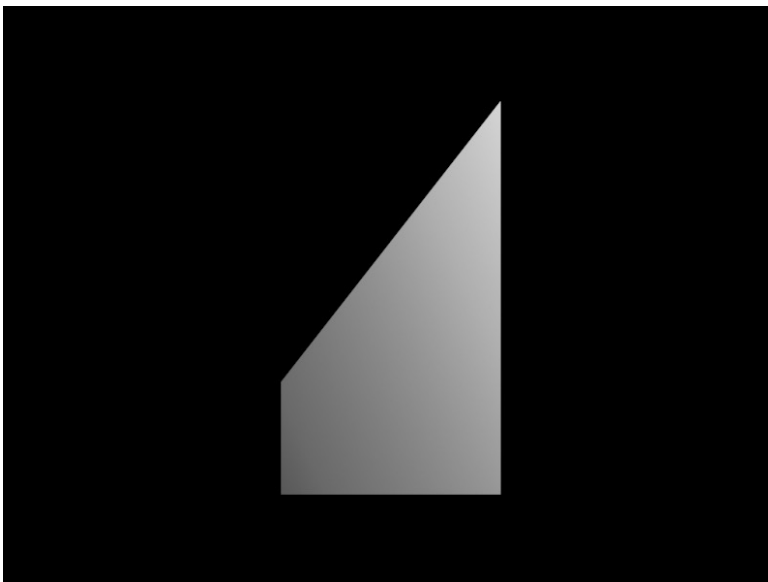
SpS_CoU_F02_79



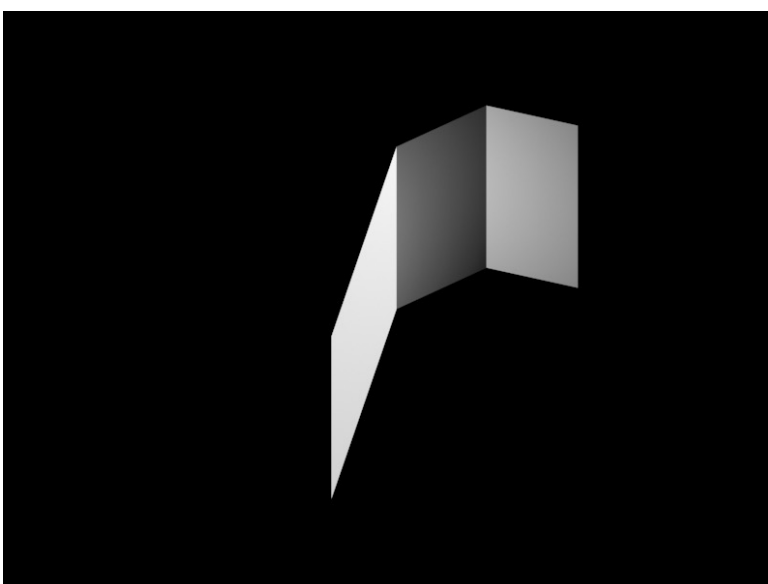
SpaceV_79



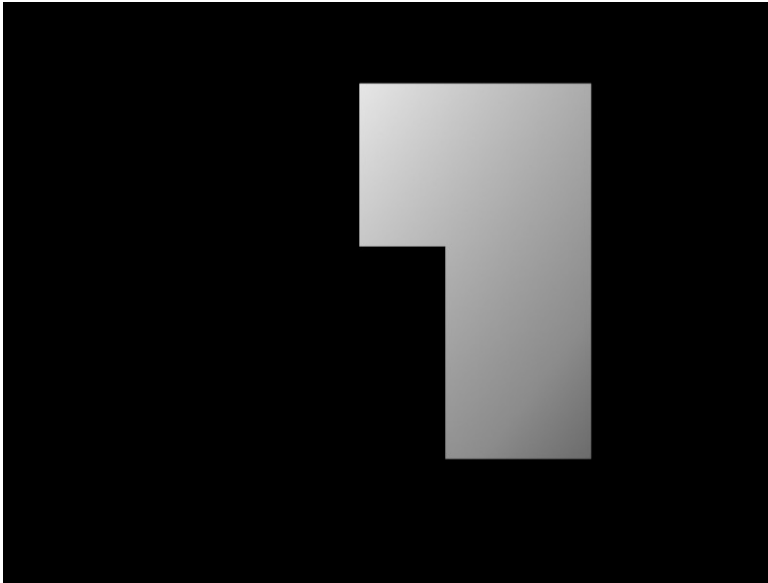
SpV_CoW_79



SpV_CoS_79



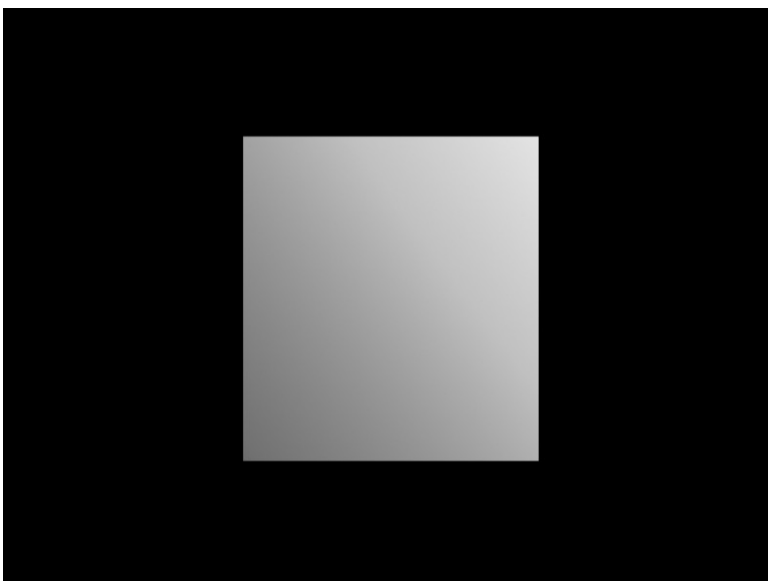
SpaceY_79



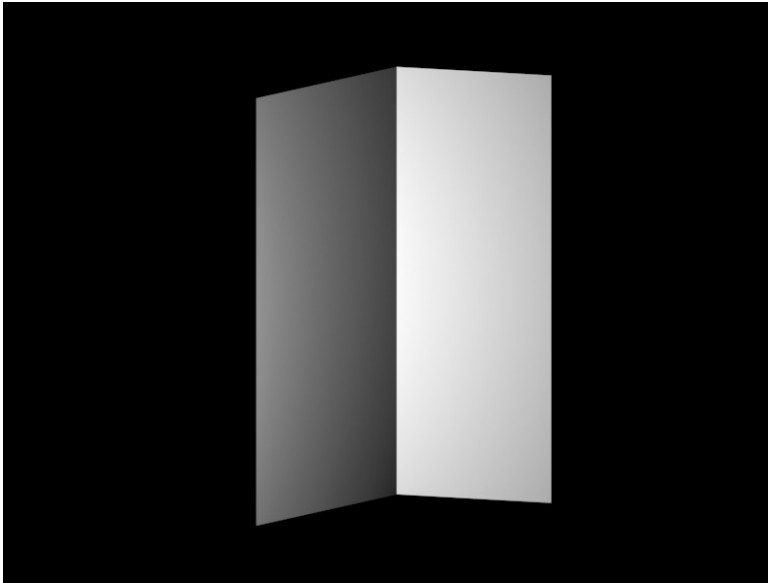
SpY_CoE_79



SpY_CoN_79



SpY_CoS_79



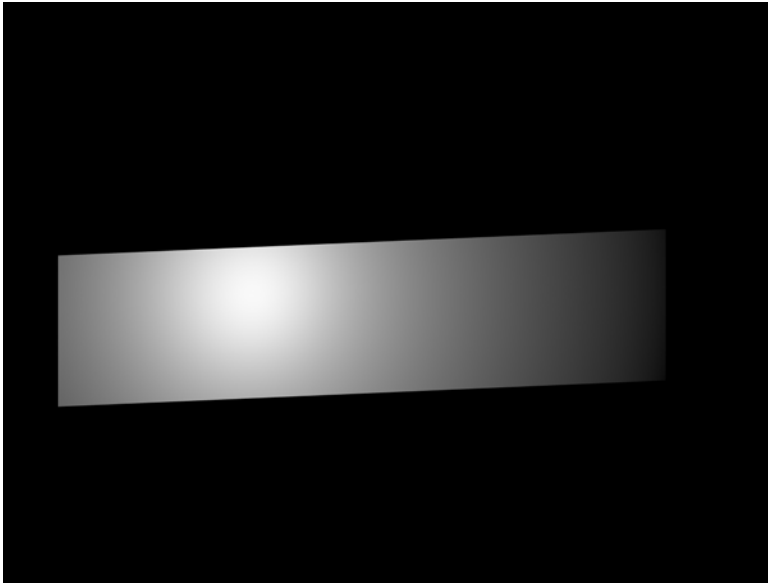
SpY_CoW_79



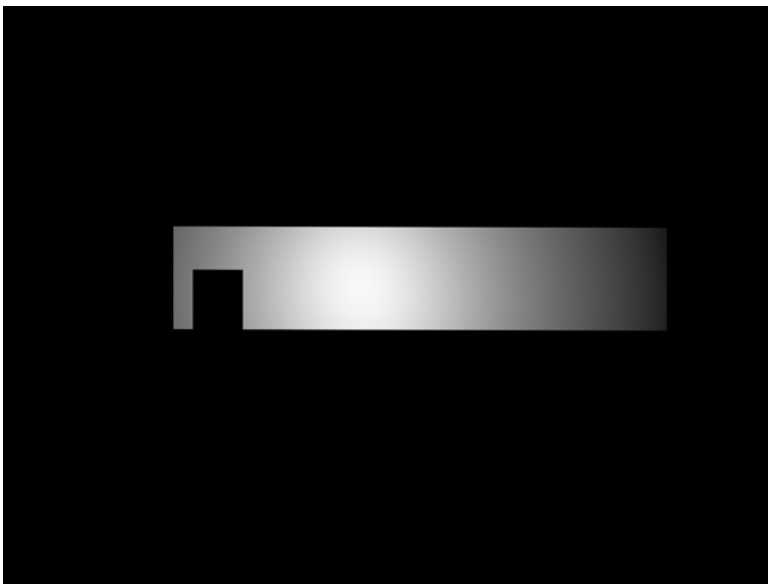
SpX_CoS_79



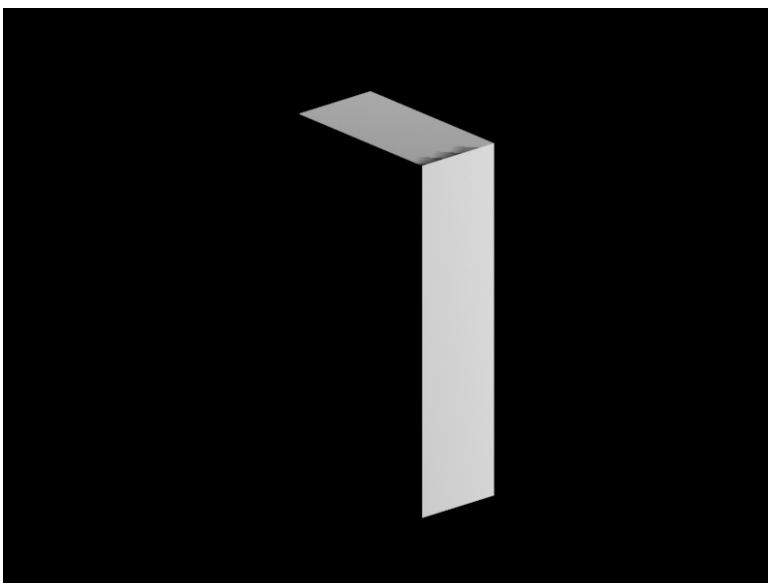
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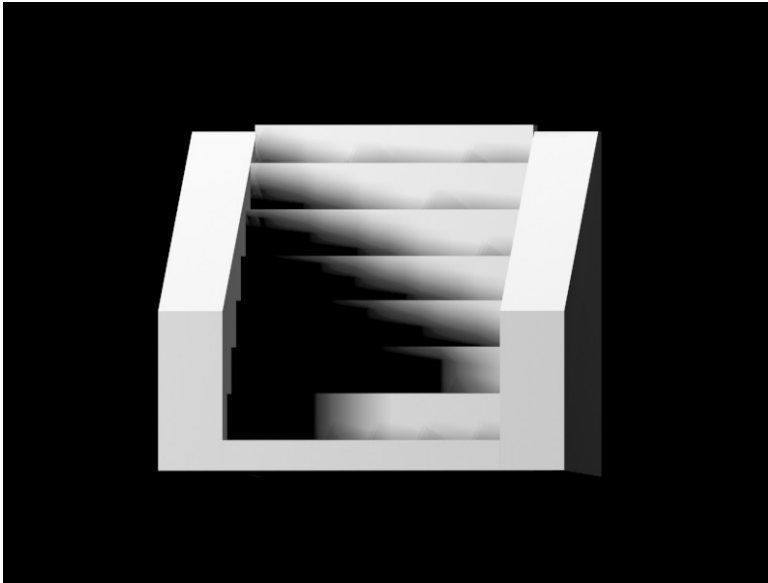
SpX_CoE_79



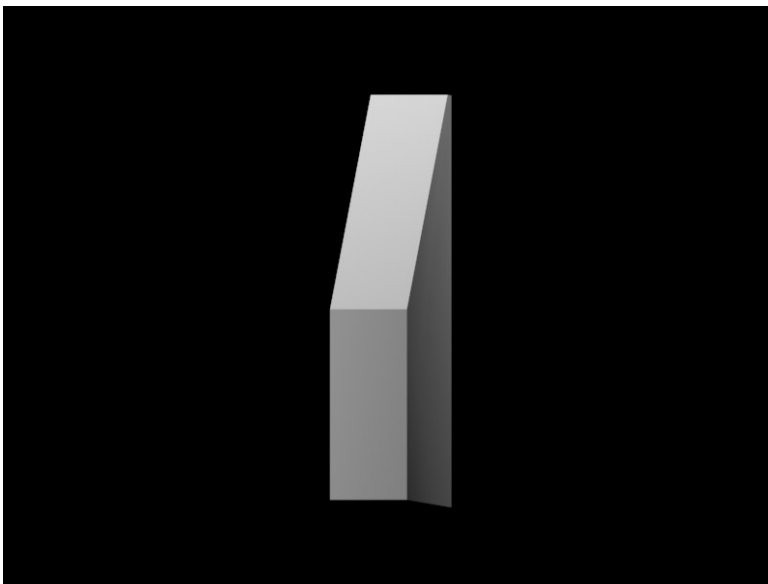
SpX_CoN_79



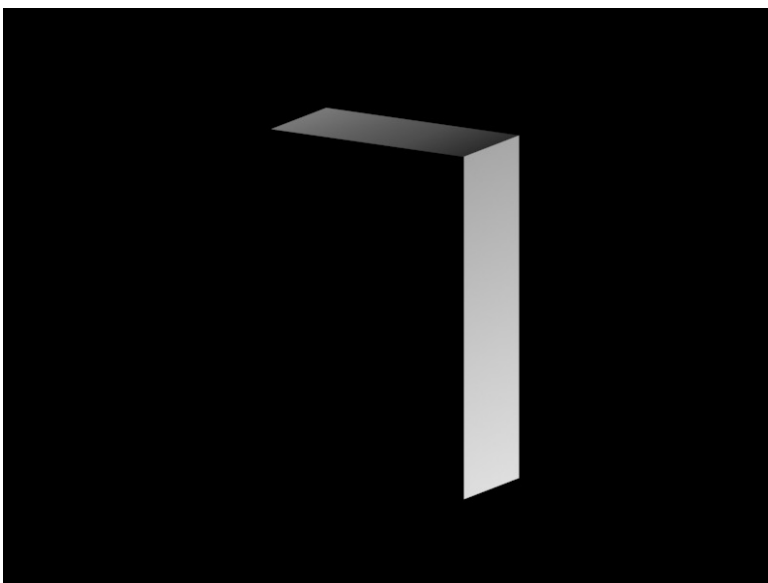
Trl_to_J01_79/
Trl_to_J02_79



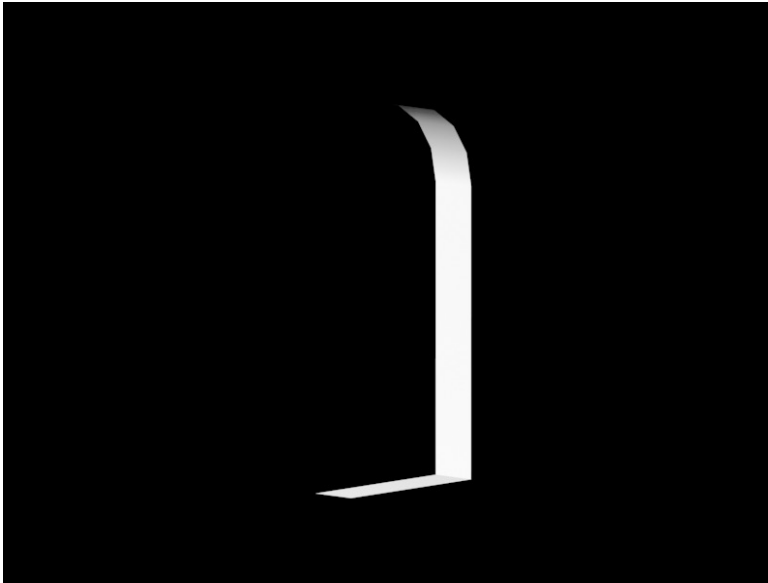
TrA_to_C_79



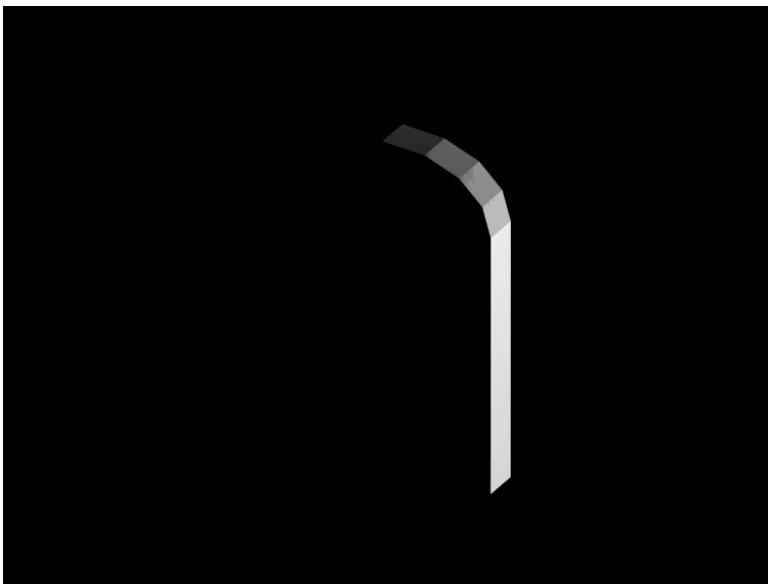
TrA_to_C_F01_79/
TrA_to_C_F02_79



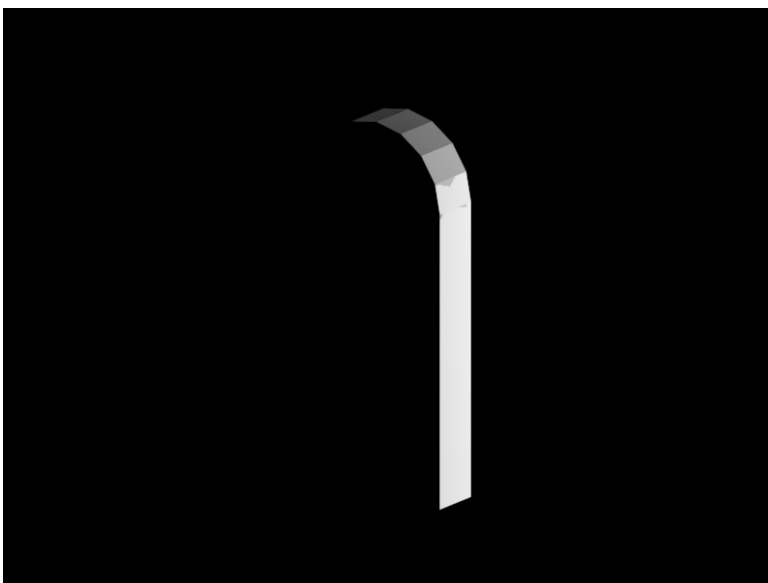
TrP_to_Q_79



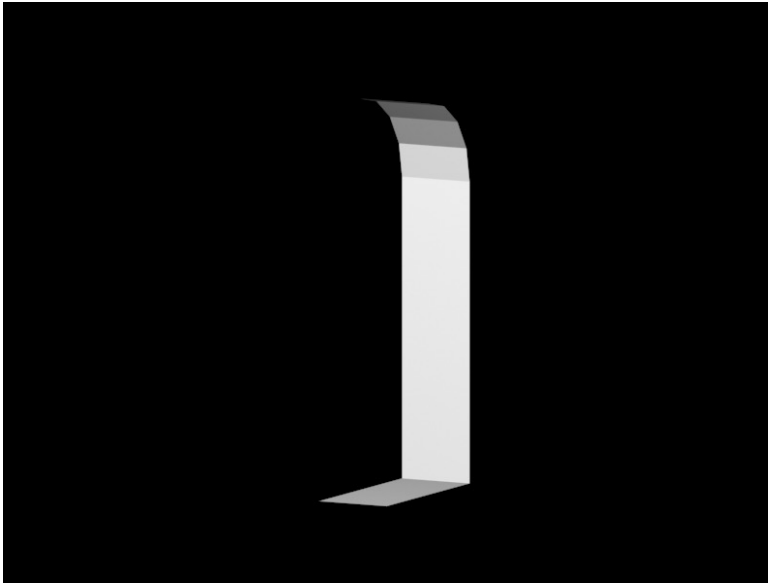
TrA_to_E01_79,
TrA_to_E02_79,
TrA_to_E04_79,
TrA_to_E05_79



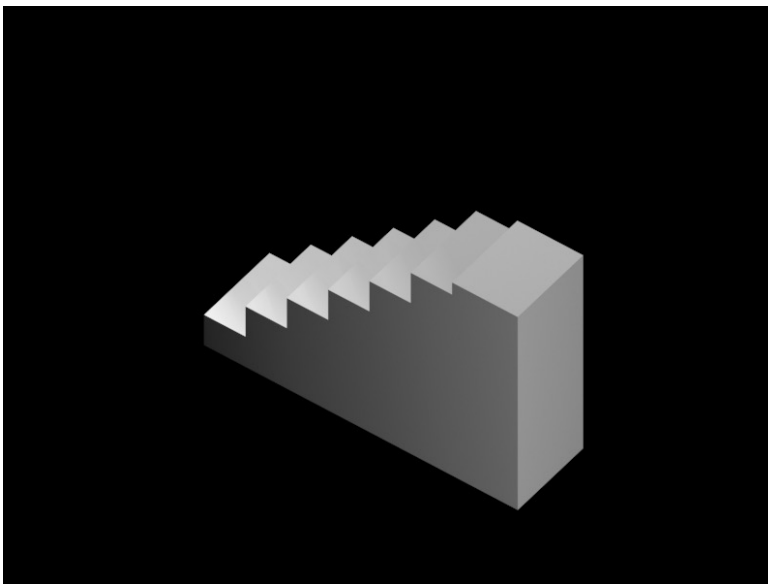
TrA_to_E03_79



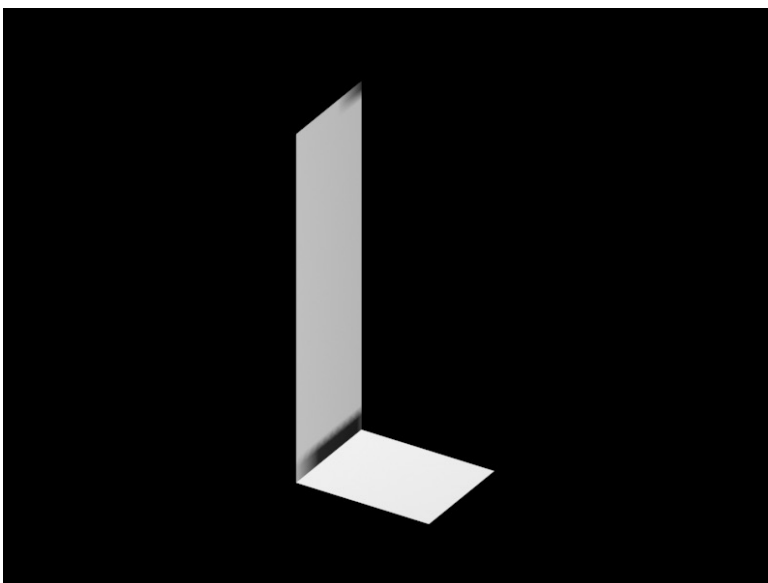
TrA_to_F_79



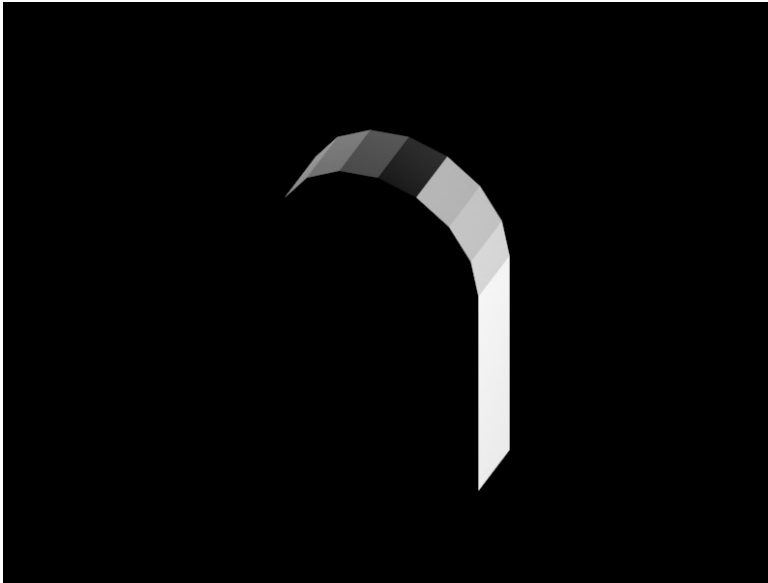
TrA_to_G_79



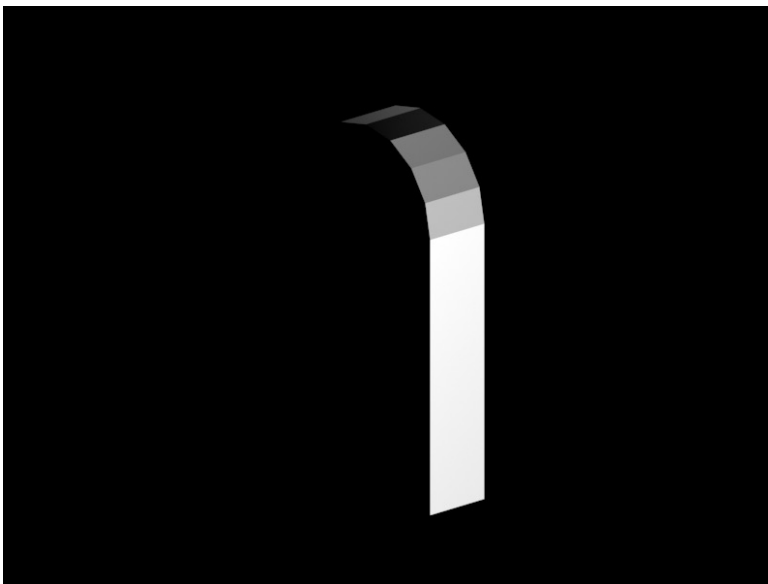
TrA_to_I01_79



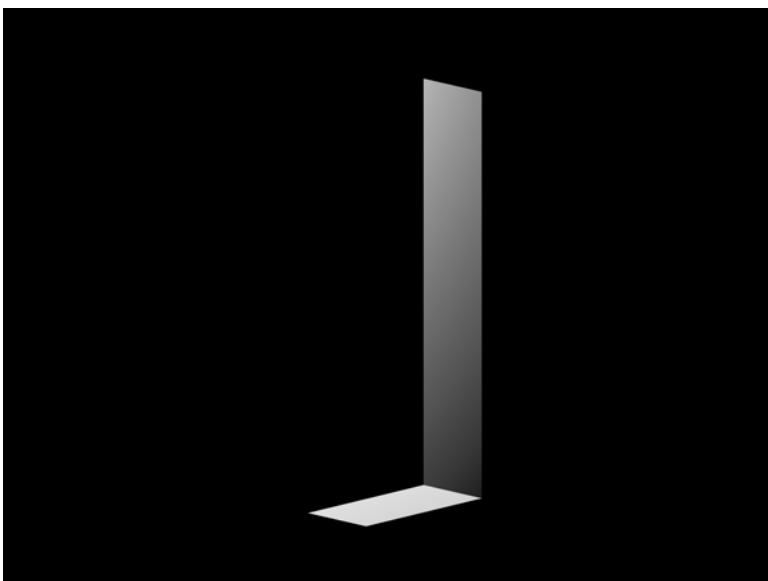
TrA_to_I02_79



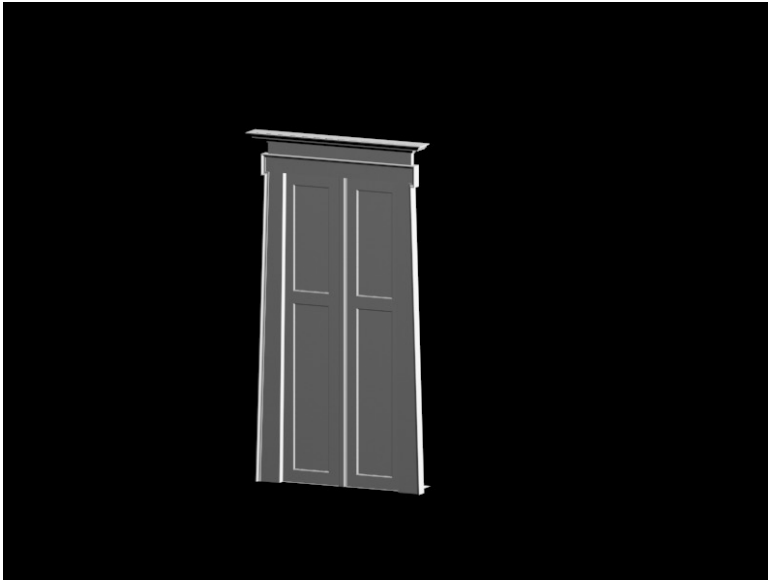
TrA_to_R_79



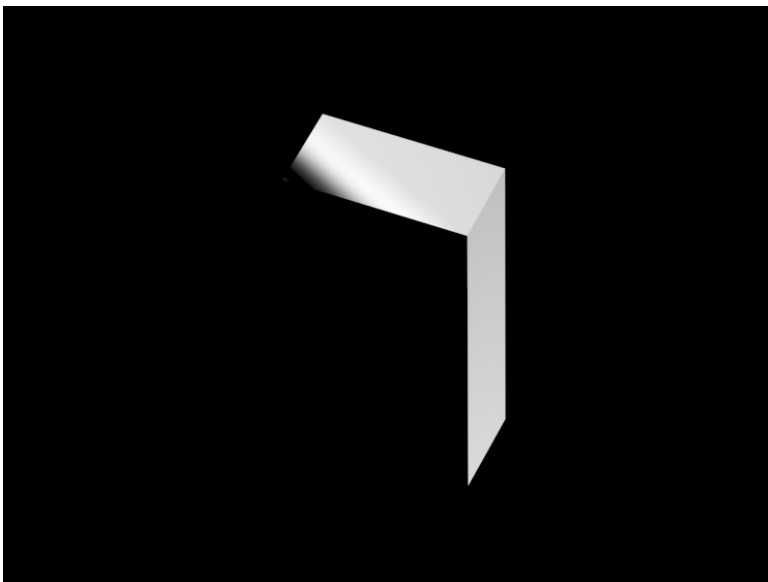
TrA_to_S_79



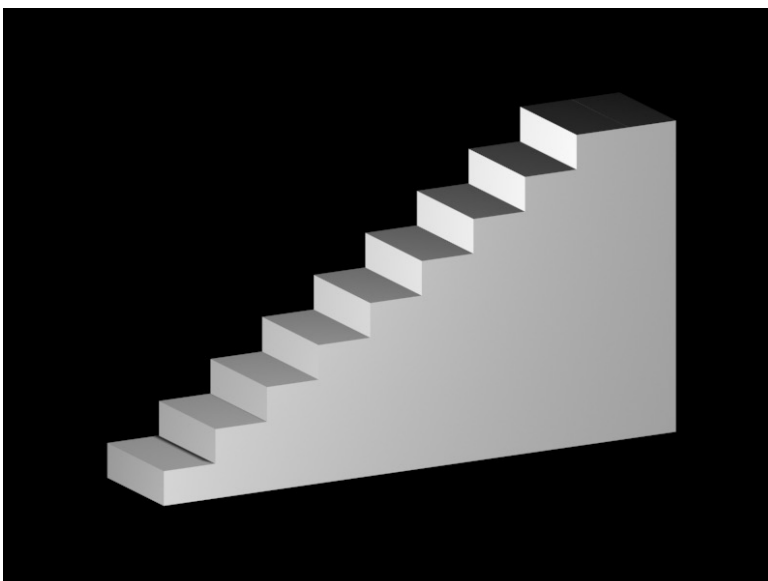
TrA_to_T_79



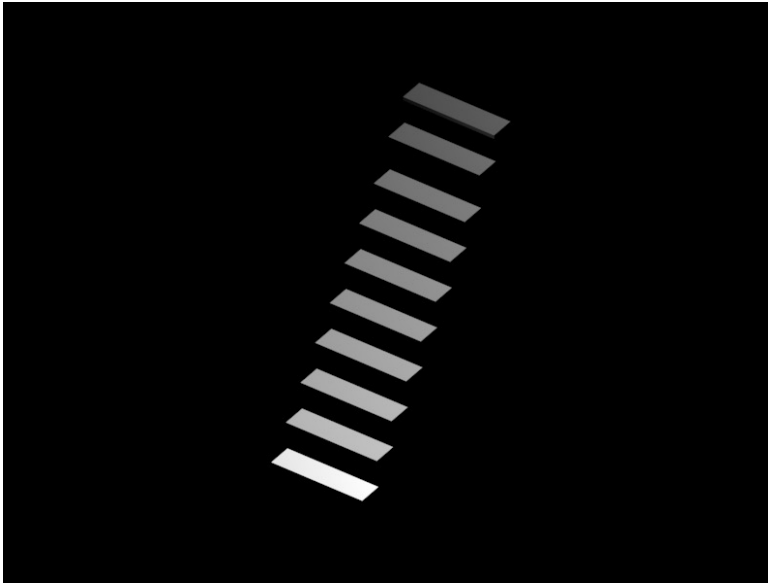
TrA_to_T_F01_79



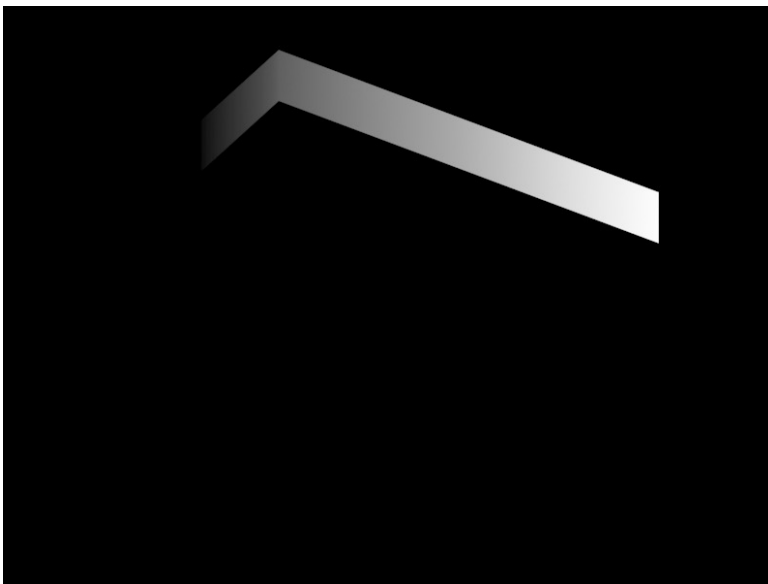
TrX_to_Q_79



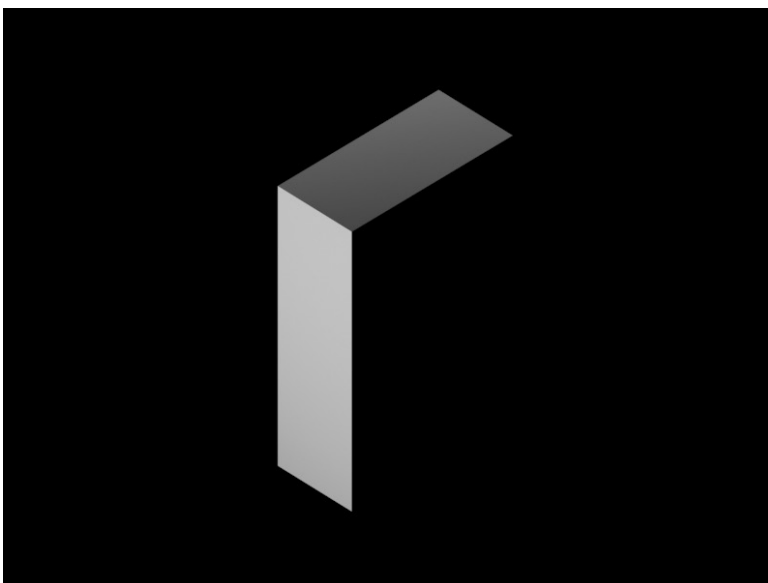
TrG_to_P01_79



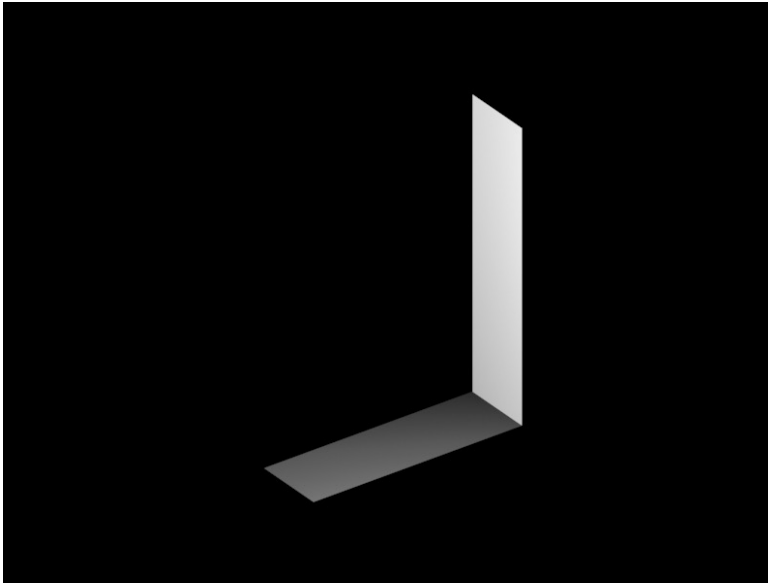
TrG_to_P02_79



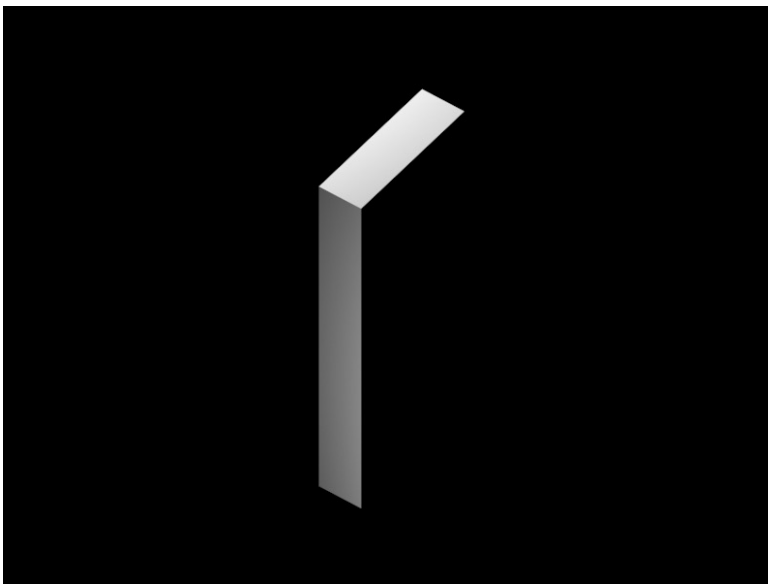
TrG_to_P03_79



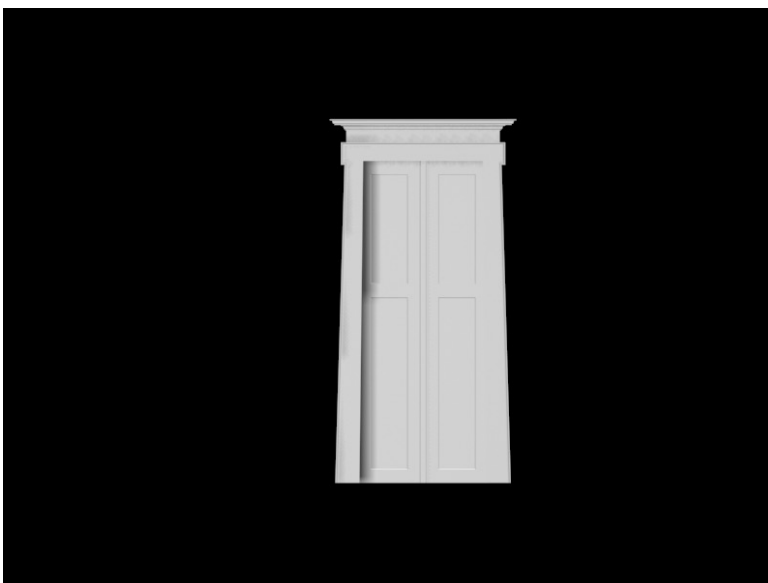
TrG_to_R_79



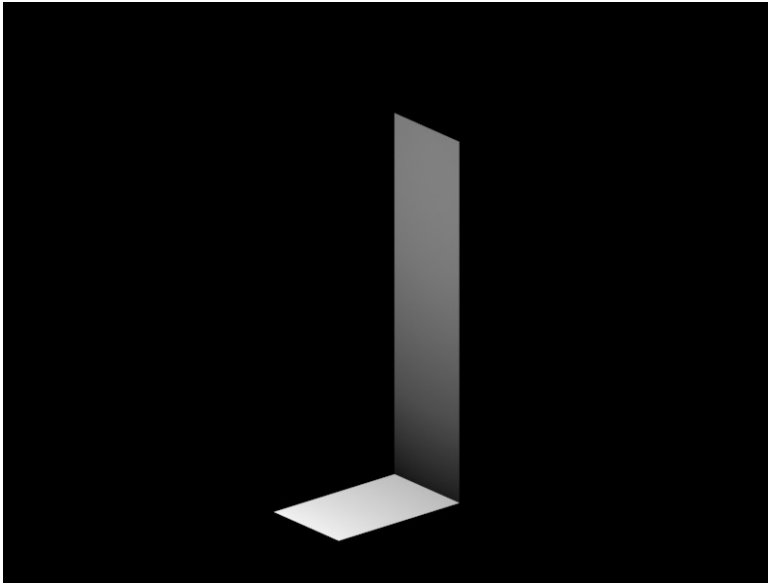
TrG_to_Y_79



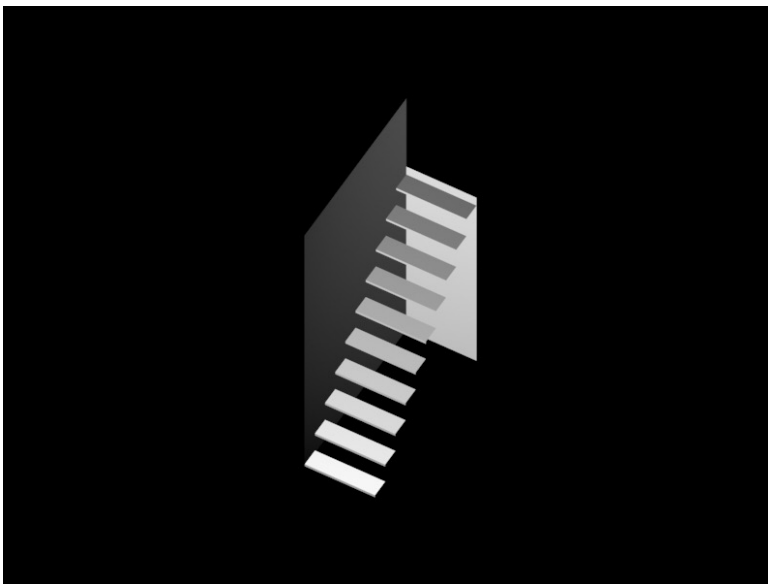
TrH_to_I_79



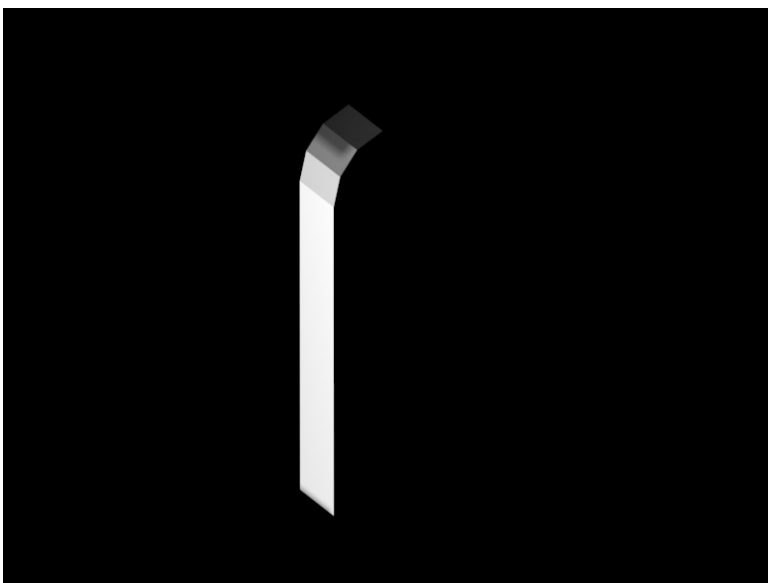
TrH_to_I_F01_79



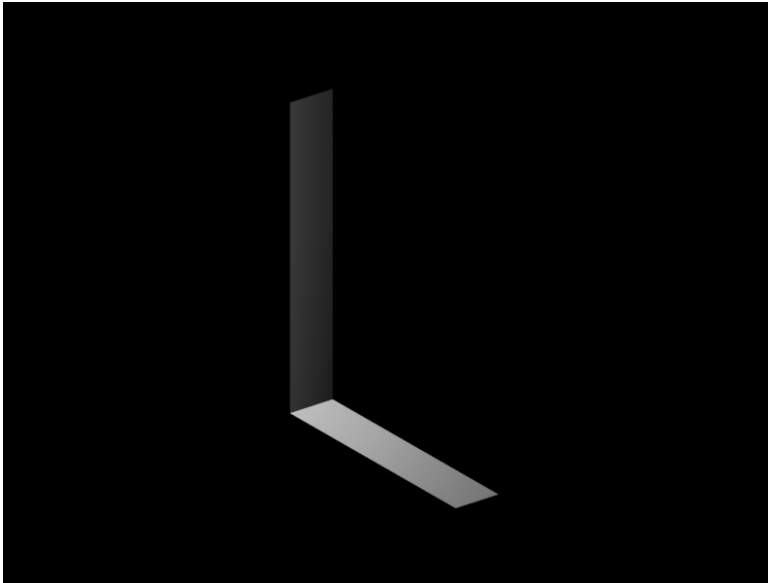
TrV_to_Y_79



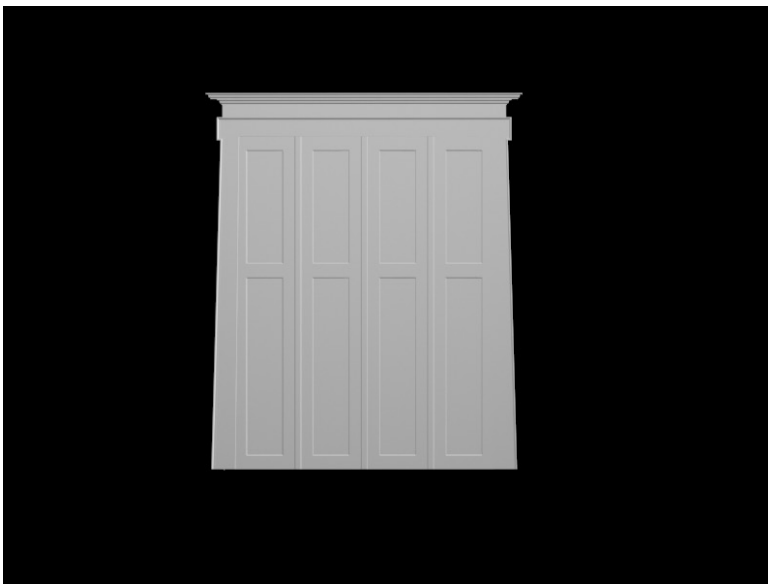
TrM_to_U01_79



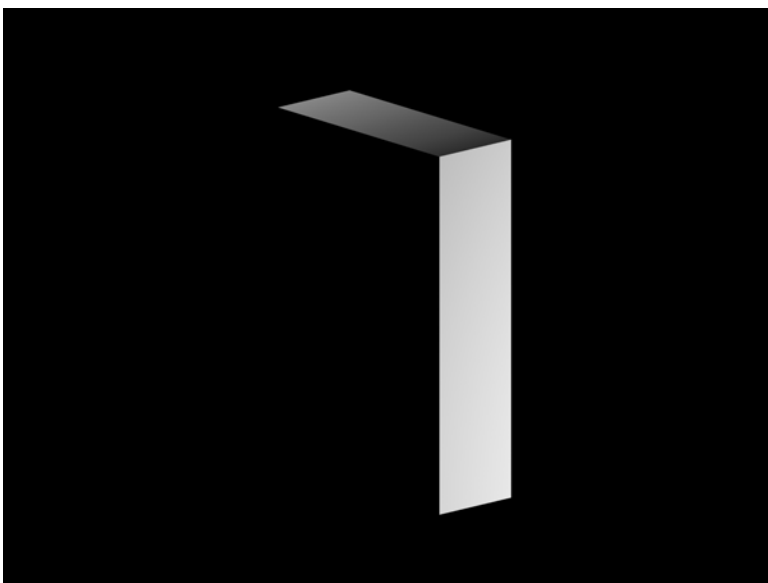
TrM_to_U02_79



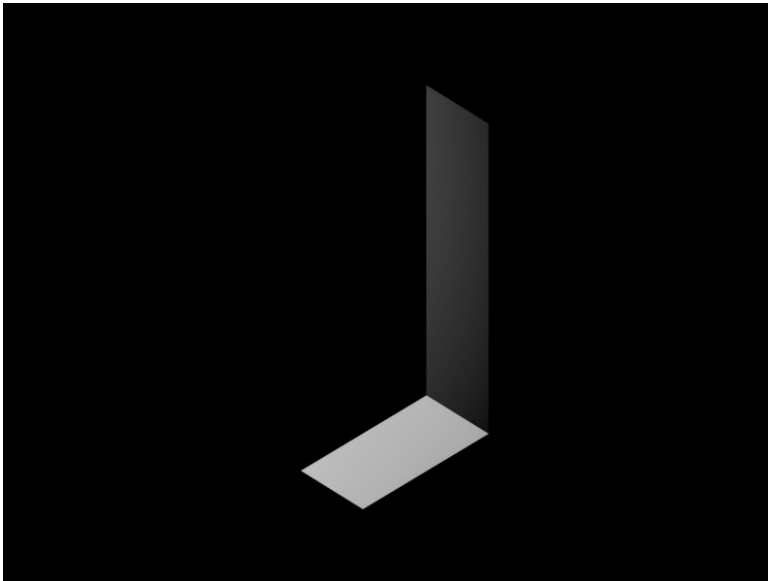
TrX_to_A01_79



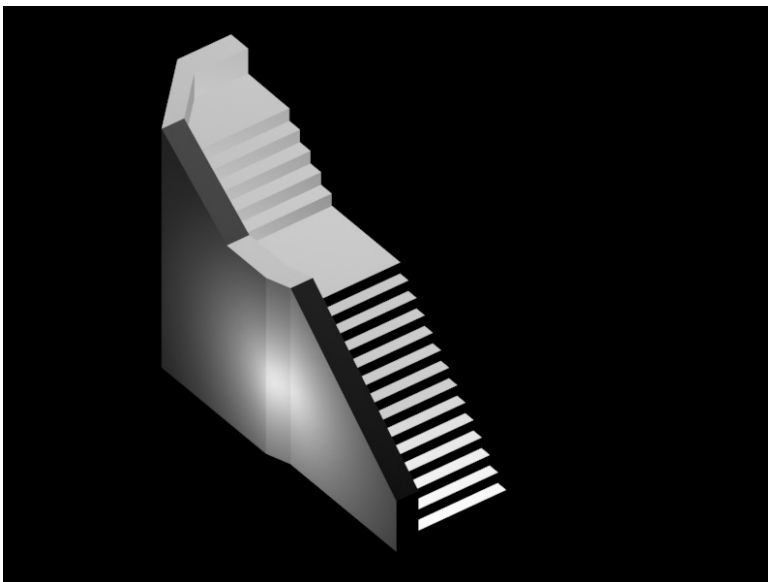
TrX_to_A01_F01_79



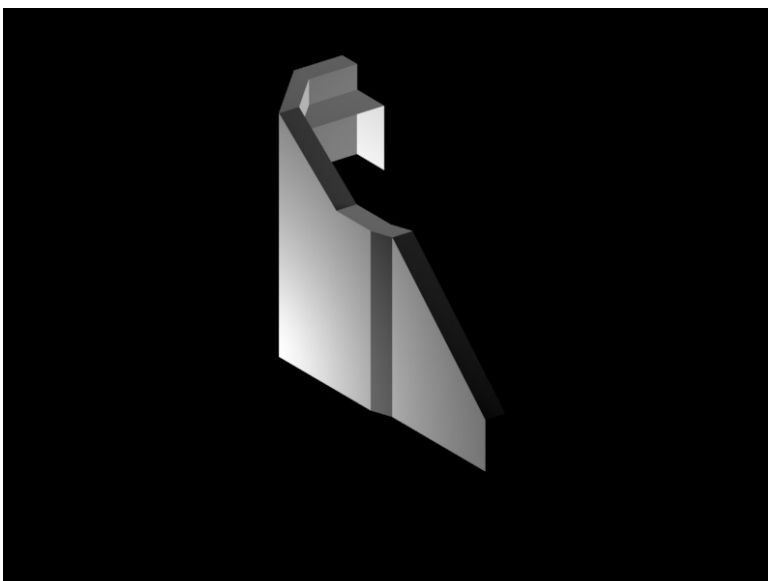
TrX_to_A02_79



TrX_to_G_79



TrX_to_O_79



TrX_to_O_F01_79



SpaceC_79 (alternative rendering)



SpaceC_79 (alternative rendering)



SpaceC_79 (alternative rendering)



SpaceC_79 (alternative rendering)